LLC "ECOTON"
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Customer: JSC "AK "Kyivvodokanal"

General Designer: SC "Institute "Kyyivinzhproekt of "JSC "Kyivproekt"

PROJECT
Reconstruction of wastewater treatment facilities and construction of new line for processing and disposal of sludge at Bortnicheskaya WWTP.

Volume 12

"Environmental Impact Assessment (EIA)" Section

Director: Gronya L.I.

Chief specialist: Kukharenko V.M.

Engineer: Solukha I.B.

Technician: Platonova Y.M.

Kyiv - 2014

ASSIGNMENT FOR PREPARATION OF EIA MATERIALS

Object name: "Project of reconstruction of sewage treatment facilities and construction of a production line for sewage-sludge treatment and utilization of the Bortnychi aeration station"

General Planner: Subsidiary Enterprise "Kyivinzhproekt Institute" of PJSC Kyivproekt

List of co-contractors: -

Construction type: reconstruction, new construction.

Location: 1a, Kolektorna St., Darnytskyi Raion in Kyiv

Project stage: project.

List of impact sources: emissions from production facilities after the reconstruction, during construction works.

List of expected negative impacts: impact on the atmosphere: ammonia NH_3, hydrogen sulfide H_2S, methane CH_4, Methyl mercaptan CH_3SH, Ethyl mercaptan C_2H_6S, carbon dioxide CO_2, saturated hydrocarbons C_{12}-C_{19}, nitrogen dioxide NO_2, carbon oxide CO and other.

List of environment components, the impacts on which are assessed: the atmosphere, aquatic environment, vegetation and other in compliance with DBN A.2.2-1-2003.

Requirements to the scope and stages of EIA: in the scope of DBN A.2.2-1-2003, in one stage of the Project

Public participation requirements: holding of public hearings, awareness through media, advisory activities.

Procedure and time frames for preparation of EIA materials: EIA procedure is in compliance with DBN A.2.2-1-2003; time frames are as per contract.

the assignment for preparation of EIA materials is supplemented with: general plan and district layout of planned facility operations, project materials.

(1) **Chief Project Engineer**
S.L. Sichkar

AGREED

(local government body)

L.S.

(title, name of the head)
2013

STATEMENT OF INTENT

1. Customer: **PJSC "JSC Kyivvodokanal"**

Postal address and e-mail: **Kyiv, 1a, Leiptsyzka St.**

2. Location of the construction site (route) (variants): **1a, Kolektorna St., Darnytskyi Raion in Kyiv**

3. Enterprise characteristics (approximately, by comparable objects): Reconstruction of sewage treatment facilities and construction of a production line for sewage-sludge treatment and utilization of the Bortnychi aeration station

In compliance with para. 20 of the "List of types of activities and objects with high environmental hazard", adopted by the Resolution of the Cabinet of Ministers of Ukraine No. 554 dd. July 27, 1995 as amended, the project facilities list as environmentally hazardous.

Technical and engineering data: Overall flow of sewage water incoming to the BAS facilities amounts to 1,573,000 m^3 per day (for January 1,2021 in compliance with the "Water supply and sewerage service diagrams for the period through to 2020", approved by the Resolution of the Kyiv City Council No. 1173/1834 dd. July 12, 2007). Designing and construction of the Bortnychi Aeration Station facilities is to be carried out in two phases with the allocation of five start-up complex for each phase (in compliance with the Design Assignment dd. October 18, 2012).

Stage I:

Start-up complex I: technical reequipment of the 2nd and 3rd block facilities to provide for the regulatory treatment of the entire volume of sewage water for the period of construction of the new 1st block with the arrangement of air cleaning systems to control odor coming from the block facilities.

Start-up complex II: construction of a section for mechanical sludge dewatering and the sewage sludge transportation and deposition facilities.

Start-up complex III: construction of a new production line for utilization of sewage water and a sewage sludge incineration facility

Start-up complex IV: construction of the 1st block with the arrangement of air cleaning systems to control odor coming from the block facilities

Start-up complex V: Preparatory works. The project provides the preparation of the territory for the construction of new buildings and facilities. The preparatory works include hydraulic fill of soil to reach design levels, clearing out of pioneer sludge fields, and the growing of dams of cascade No. 5 of sludge fields No. 2 to enable transportation of sludge from pioneer sludge fields.

Stage II:

Start-up complex VI: reconstruction of the "Pozniaky" sewage pumping station with the arrangement of an odor control system.

Start-up complex VII: reconstruction of the "Pravoberezhna" sewage pumping station with the arrangement of an odor control system.

Start-up complex VIII: construction of the new 2nd station block.

Start-up complex IX: reconstruction of the 3rd station block facilities.

Start-up complex X: reconstruction of the effluent discharge channel and dissipating discharge pipes. construction of vehicle garage and repair departments.

Service lifetime is over 50 years (Types and volumes of products delivered, service lifetime).

4. Social and economic necessity of the project activities: public service facilities: for reconstruction of sewage water facilities and construction of a production line for sewage-sludge treatment and utilization, treatment of odor coming from the BAS facilities.

5. Resources requirement during construction and operation:

land: no additional allocation of land is required, the construction is being undertaken within regular land allocation: within the territory of the BAS facilities and territories of the "Pozniaky" and "Pravoberezhna" sewage pumping stations (SPS).

(area of land withdrawn for temporary and regular use, type of use)

Raw materials: use of reinforced concrete structures and other materials during reconstruction and construction of the BAS facilities and odor control system (filters set-up).

(types, volumes, place of exploitation and extraction, sources)

Energy (fuel, power, heat): electric power is obtained from the existing power networks. Power supply of the BAS is provided according to the Category I as to continuity of power supply of the Joint-Stock Power-Supplying Company Kyivenergo: 110/35/63-10 kilovolt from Bortnychi district substation, 110/6.3 kilowatt from “Luhova” substation, 110/6.3 kilowatt from “Dniprovska” substation.

Water: from the BAS water supply networks (volumes, required quality, water supply sources)

Labor: according to cost estimate and staffing table

6. Transportation support (during construction and operation): delivery of construction materials and structures by motor vehicle. A need for mechanisms and construction transport is specified in the POB section.

During the operation open-air visitor parking lots for employees and technical transport parking lots will be provided.

7. Environmental and other restrictions of planned facility operations by variants: the project will cover environmental, sanitation and hygiene, fire protection, planning, and territorial restrictions in compliance with the applicable regulatory documents.

8. Necessary environmental and engineering preparation and protection of the territory by variants: topographic and geodesic, engineering and geological and other types of exploration are performed to the extent required.

Project solutions will provide for the implementation of DBN and sanitation and hygiene standards / regulations, as well as guarding, remediation, and protective measures. Provisions are made for the improvement of adjacent territory.

9. Potential impact of planned facility operations (during construction and operation) on environment and types of impacts on:

Climate and microclimate: there are sources impacting on the climate and microclimate. the impact is within the normal range.

Geological environment: the impact is present, but due to the measures taken the impact remains within the range of applicable standards.

Aerial environment: the impact is present during operation. The project provides for the treatment of polluted air on filters. the impact is insignificant during construction.

Concentrations of hazardous substances in the atmosphere both from the designed facilities and during construction works do not exceed standards of maximum allowable concentration (MAC) within the sanitary protection zone (SPZ).

Aquatic environment: the impact is present within the range of applicable standards. After all work for the BAS reconstruction has been completed, production lines for sewage water treatment should ensure their biological treatment. Treated water indicators comply with the applicable standards.

Soils: the impact is present within the range of applicable standards.

Plant and animal life, protected areas: the impact is present as compensated.

Social environment: the impact is positive.

Anthropogenic environment: project solutions will comply with the construction requirements and regulations.

10. Production waste and possibility of its recirculation, utilization, handling or safe disposal: during the construction works such waste as depleted soil, construction waste is produced. the project provides for the waste collection and disposal immediately after its extraction. Types of waste during operation: contaminants on screens, sand from degritters, raw sludge from primary sedimentation tanks, surplus activate sludge, sediments from silt fields. Project provides for the construction of a new production line for treatment and utilization of sludge from all three station's blocks, as well as sludge accumulated on silt fields.

11. Scope of EIA to be made: **within the scope set out in the requirements of DBN A.2.2-1-2003**

12. Public participation: **publications in mass media, holding of consultations and explanatory activities through the end of 2013. Customer's address: Kyiv, 1a, Leiptsyzka St., tel. 226-30-38.**

(address, telephone number and time of familiarization with the project and EIA materials, time of proposal submission)

Customer	General Designer
Chairman of the Board of PJSC "JSC Kyivvodokanal" A.O. Bilyk	Director of Subsidiary Enterprise "Kyivinzhproekt Institute" of LLC NVPI Kyivproekt M.S. Marchenko

STATEMENT OF ENVIRONMENTAL IMPACT ASSESSMENT

Facility: "Rehabilitation of wastewater treatment facilities and construction of production line for processing and disposal of sludge at Bortnychi WWTP" project (revised). Design and cost estimates developed on the basis of:

- Resolution of the Cabinet of Ministers of Ukraine № 933 from 03.10.2012 "On some issues of construction and cost estimation documents for Bortnychi WWTP in Kyiv"
- Order of the Cabinet of Ministers of Ukraine № 279 of 17.05.2012 "On the allocation of funds for 2012 emergency environmental protection measures for the construction and cost estimation documents for sewerage facilities"
- Agreement No. D-15/266-2012 of 16.10.2012 regarding the delegation of customer functions for implementation of urgent environmental measures for the construction and cost estimation documents for Bortytskaya WWTP in Kyiv in 2012, concluded between PJSC "AK" Kyivvodokanal" and Ministry of Regional Development, Construction, Housing and Utility Services of Ukraine.
- Decree of Ministry of Regional Development, Construction, Housing and Utility Services of Ukraine № 527 of 16.10.2012 "On organization of implementation of the Order by the Cabinet of Ministers of 03.10.2012 № 933"
- Order of Kyiv City State Administration (KSCA) № 1549 of 07.11.2008 "On Approval of "Feasibility study of the reconstruction of wastewater treatment facilities and sewage construction process line for processing and disposal of sludge in the Bortnychi WWTP"
- Task for design of reconstruction of wastewater treatment facilities and construction of technological line for processing and disposal of sludge in the Bortnychi WWTP, approved by the KSCA representative and agreed by the representative of Ministry of Regional Development, Construction, Housing and Utility Services of Ukraine, from 18/10/2012.
- Terms of reference (Appendix to "Task for design of reconstruction of wastewater treatment facilities and construction of technological line for processing and disposal of sludge in the Bortnychi WWTP), approved by the decision of Technical Council of PJSC "AK" "Kyivvodokanal" and Chairman of Board of PJSC "AK" "Kyivvodokanal" from 18.10.2012
- materials, prepared by SE "Institute "Kyiivinzhproekt" PAT "Kyivproekt", 2013;
- technical and commercial proposals.

The purpose of the design activity is to ensure normal operation of BAS facilities, by establishment of production lines of wastewater treatment that will ensure their full

biological treatment at each of the 3 Blocks, construction of a new manufacturing line of treatment and disposal of sludge, installation of deodorization systems with treatment of contaminated using filters.

The means to achieve the goals and implement the design activities:
According to the design, full reconstruction of treatment facilities, technical infrastructure, landscaping, treatment technology and sludge disposal are provided, and are carried out in the following sequence:

Stage 1

Component 1: - technical re-construction of the facilities of Blocks 2 and 3 to ensure quality treatment of the entire volume of wastewater during construction of the new Block 1 with installation of air deodorization systems at Block facilities.
Component 2 - Construction of the section of mechanical dewatering of sewage sludge
Component 3 - Construction of the technological line of disposal of sewage sludge
Component 4 - Construction of new Block 1.
Component 5 - Preparatory works

Stage 2

Component 6 - Reconstruction of sewage pumping station "Pozniaky" with installation of air deodorizing system.
Component 7 - Reconstruction of sewage pumping station "Pravoberezhna" with installation of air deodorizing system
Component 8 - Construction of the new Block 2 of the station.
Component 9 - Reconstruction of the facilities of Block 3 of the station.
Component 10 - Reconstruction of the main effluent channel and dissipating discharge. Construction of motor transport and repair shops.
Consideration of public opinion - given that this project envisages reconstruction of sewage facilities and the construction of technological line for treatment and disposal of sludge of Bortnychi WWTP, public hearings are required.

ENVIRONMENTAL IMPACTS ASSESSMENT:

(1) Environmental Impacts Assessment during Operation Phase

Impact on Hydro-geological environment

There is no risk of soil or ground water contamination. Design solutions eliminate impact risks on hydro -geological environment. Ground subsidence is not a risk without extraction of groundwater for the project. No wastes to be generated will be disposed directly on ground.

Use of Land Resources, Landscape

The project will have no needs for further reallocations of land resources for the continued operation.

Impact on Air Environment

The current sewage treatment operations emit unpleasant odors beyond the premise of BAS mainly consisting of mercaptan, ethyl-mercaptan, and hydrogen sulfide. These odor-emitting substances will be greatly reduced by the new and upgraded process. The new sources of pollutants in the atmosphere after project implementation will come from the new incinerators. The new pollutants will include nitrogen dioxide, sulfides, hydrochloric acid, and heavy metals. The emission levels are contained well within the emission standards and marginally contribute to the ambient air concentrations. It is possible that the nitrogen dioxide levels may exceed the allowed maximum ambient concentration due to the high prevailing concentrations in the background. For other substances, the ambient concentrations will stay within the standard limits.

Impact on Aquatic environment

The current water treatment is failing in meeting effluent standards in terms of nitrogen and phosphorous, posing some risk of degrading drinking water source for the villages and some risk of eutrophication in the Kaniv Reservoir downstream. After the implementation of the project, the quality of treatment will conform to the requirements for waters of cultural and community purpose.

Waste Generation

The currently generated sludge has seriously undermined the processing capacities of the wastewater treatment lines of the BAS due to recycling of wastewater generated at the sludge disposal sites. The disposed sludge which used to be reused as fertilizer prior to the ban in 1986 has been accumulated to nearly the maximum holding capacities. KVK is now undertaking the raising the height of the embankments to extend the useful life for several years.

The proposed incineration is the only feasible solution to the ever-increasing volume of sewerage sludge.

Impact on Climate and Micro-climate

The current operations and operations to be introduced by the Project both will emit the greenhouse gasses of carbon dioxides, methane. However, the total effects will be likely to reduce.

The estimated annual carbon dioxides equivalent values will witness a significant reduction in global warming impacts.

Impact on Flora and Fauna

The designed activities are not connected with large-scale removal of green space. Given the fact that the project will improve both aquatic environmental impacts and most of ambient air qualities, there will be no immediate impacts on the ecosystem of flora and fauna.

Protection of Nature Reserves

There is no parks or natural reserves within the Project site or in its vicinity to be protected from influences for the Project.

Electromagnetic Field Impact

Electromagnetic non-ionizing radiation will emanate from the electric fields around substation equipment and conductors. However, the anticipated impact is minimal because only extremely low frequency fields are generated from substations.

Noise and Vibrations

There will be some motor, pump noises generated for the operation of sewage treatment. However, the noise level will be contained within the buildings of BAS. The caution may be taken for the protection of labor and laborer safety.

Impact on Infrastructures and Artificial Objects

Given the nature of the Project, i. e. rehabiliation, the Project does not impose any extra load on the existing infrastrucutres except for the period of construction. The current method of stockpiling of sludge in the sludge fields will necessitate additional sludge fields and embankments to be established for ever growing stock of sludges which cannot be recycled. Thus the project will eleminate the needs for continuous sludge field development.

Impact on Local Economy and Society

The influent water to the BAS is only sewage to be treated thus there is no infringment of water rights of other memebers of society. There is no extra allocation of natural resources specific to the project, thus there is no direct impact on local economy. There is no significant objects of cultural and historical importance within the Project area. Thus the Project poses no conflict of interest or requirements of instituaitonal changes.

Resettlement

The Project does not require no significant space for land.

Accidents and Disease

Actual planning and development of manuals, instructions, and awareness raising program should be developed during the detail design stage for the prevention of accidents related to fires, electroexecution, traffic accidents and other public health related matters.

(2) Environmental Impacts Assessment during Construction Phase

Impact on Hydro-geological environment

No immediate impacts are expected with proper construction management.

Use of Land Resources, Landscape

A somewhat large scale of laborforce will be deployed during the period of construction. There will be some organized training on communication with neighboring communities etc. The location of the construction sites are relatively secluded to maintain buffer with the neighboring communities.

Impact on Air Environment

Construction activities will generate minor volumes of dust and other pollutants. However, the level of pollution is within allowable limits to be minimized through well-designed environmental management plan.

Impact on Aquatic environment

Construction activities will generate minor volumes of wastewater by washing of construction and transport machinery without significant impacts. Water supply and sewerage service will be provided to the labor camp for construction.

Waste Generation

Construction waste will be generated in a large quantity. Oils and other wastes may be generated in a minor quantity due to construction activities by heavy and transport machines. The generated wastes will be transported to the city's landfill site for proper disposal. The procedure will be included in the planned environmental management plan.

Impact on Climate and Micro-climate

There will be minor emission of greenhouse gasses without significant impacts mostly by transport vehicles.

Impact on Flora and Fauna

There will be no impacts on wild life or vegetation during construction.

Protection of Nature Reserves

There is no nature reserves or parks infringed by construction activities.

Electromagnetic Field Impact

No major construction activities will emanate significant electromagnetic radiation.

Noise and Vibrations

Construction activities will generate minor volumes of noise and vibrations within tolerable impacts with proper construction management.

Impact on Infrastructures and Artificial Objects

Higher volumes of traffic during construction may pose extra loads on road infrastructures. However, the location of BAS at the end of a feeder road, there is no significant traffic jams to be expected in the vicity.

Impact on Local Economy and Society

Construction activities are expected to generate more jobs and induced consumption to provide positive impacts to local economy.

Resettlement

The space required for labor camp for construction can be allocated within the premise of BAS.

Accidents and Disease

Actual planning and development of manuals, instructions, and awareness raising program should be developed during the detail design stage to avoid accidents and damages related to falling, falling objects, fires, electroexecution, traffic accidents, and infectious diseases within tolerable impacts with proper construction management.

PUBLIC BENEFITS FROM THE IMPLEMENTATION OF THE DESIGN ACTIVITIES:

- improving the quality of wastewater treatment at BAS facilities and construction of technological line for processing and disposal of sludge of BAS, providing deodorization of the polluted air of odors by filters;
- creation of new jobs;

OBLIGATIONS OF THE CUSTOMER:

- construction and operation of design facilities in accordance with the standards and rules of maintaining PS and the environmental safety requirements;
- compliance with environmental restrictions according to the EIA;
- application of safeguard measures as per the list above;

- disposal of construction waste;
- landscaping of the territory.

Customer	General Designer
Chairman of the Board of PJSC “JSC Kyivvodokanal” A.O. Bilyk	Director of Subsidiary Enterprise “Kyivinzhproekt Institute” of LLC “NVPI “Kyivproekt” M.S. Marchenko

CONTENTS

p.

ENVIRONMENTAL IMPACTS ASSESSMENT: viii
PUBLIC BENEFITS FROM THE IMPLEMENTATION OF THE DESIGN ACTIVITIES: xi
OBLIGATIONS OF THE CUSTOMER: xi
1. ABSTRACT 1
2. LEGAL AND REGULATORY FRAMEWORK 3
2.1. Policies, Laws and Regulations Related to Environmental and Social Considerations 3
2.1.1. Environmental Policy 3
2.1.2. Laws and Regulations on Environmental and Social considerations 4
2.1.3. Law of Ukraine "On Environmental Protection (June 25, 1991) 5
2.1.4. Law on urban development (12 March, 2011) 6
2.1.5. Regulations on EIA 7
2.1.6. Regulations for Public hearings 7
2.1.7. Process of Preparing EIA, Review and Approval 9
2.1.8. Preparation and Notification 11
2.1.9. Public hearings 12
2.1.10. After Public hearings 12
3. GROUNDS FOR EIA 13
3.1. General Background 13
3.1.1. Political Decisions 13
3.1.2. Rationale of Project 14
3.1.3. Existing Production Structure of BAS 17
3.1.4. Process Scheme of Bortnychi WWTP 19
3.1.5. Characteristics of Sewage Sludge of Bortnychi WWTP 20
3.2. List of Restrictions 21
3.3. Information on Relation of Public to the Planned Activity 22
4. PHYSICO-GEOGRAPHIC AND CLIMATIC CHARACTERISTICS OF THE PROJECT AREA 24
4.1. General Description of Project Area 24
4.2. Geology 28
4.3. Hydrology 30
4.4. Flora and Fauna 31
4.5. Climatic Conditions 32
4.6. Society and Economy 35
5. ANALYSIS OF ALTERNATIVES 38
5.1. Alternatives for sludge treatment and disposal 38
6. Proposed Plan and EIA Scoping 40
6.1. Current Facilities and Operation 40
6.1.1. General Situation 40
6.1.2. Sludge Disposal 40
6.2. Design Solutions 41
6.2.1. Sludge Treatment 48
6.3. Scope of Environmental Impacts Assessment During Operation Phase 64
6.3.1. Impact on Hydro-geological environment 65
6.3.2. Use of Land Resources, Landscape 65
6.3.3. Impact on Air Environment 65
6.3.4. Impact on Aquatic environment 65

6.3.5. Waste Generation 66
6.3.6. Impact on Climate and Micro-climate 66
6.3.7. Impact on Flora and Fauna 66
6.3.8. Protection of Nature Reserves 66
6.3.9. Electromagnetic Field Impact 67
6.3.10. Noise and Vibrations 67
6.3.11. Impact on Infrastructures and Artificial Objects 67
6.3.12. Impact on Local Economy and Society 67
6.3.13. Resettlement 67
6.3.14. Accidents and Disease 68
6.4. Scope of Environmental Impacts Assessment During Construction Phase 68
6.4.1. Impact on Hydro-geological environment 68
6.4.2. Use of Land Resources, Landscape 69
6.4.3. Impact on Air Environment 69
6.4.4. Impact on Aquatic environment 69
6.4.5. Waste Generation 69
6.4.6. Impact on Climate and Micro-climate 69
6.4.7. Impact on Flora and Fauna 69
6.4.8. Protection of Nature Reserves 69
6.4.9. Electromagnetic Field Impact 69
6.4.10. Noise and Vibrations 70
6.4.11. Impact on Infrastructures and Artificial Objects 70
6.4.12. Impact on Local Economy and Society 70
6.4.13. Resettlement 70
6.4.14. Accidents and Disease 70
7. ASSESSMENT OF IMPACT OF PLANNED ACTIVITIES ON ENVIRONMENT 72
7.1. Air Environment 72
7.1.1. Ambient Concentration Standards 72
7.1.2. Indicators and Criteria for Assessment of Atmosphere 73
7.1.3. Background Ambient Concentration of Pollutants 74
7.1.4. Current Ambient Pollutant Concentrations 74
7.1.5. Odor Problems of BAS 75
7.1.6. Characteristics of Design Facility as Source of Ambient Air Pollution 76
7.1.7. Forecast for Emission Mass in the zone of design activities 79
7.1.8. Calculation of atmosphere pollution (CAP) by the object 79
7.1.9. Impacts on Ambient Pollutants Concentrations 80
7.2. Aquatic environment 96
7.2.1. Environmental Standards 96
7.2.2. Current Status on Aquatic Environment 98
7.2.3. Current Impact on Aquatic Environment 101
7.2.4. Sewage treatment facilities 104
7.2.5. Project Load 105
7.2.6. Future Effluent Quality 105
7.2.7. Parking Lot and Car Wash Wastewater Treatment 107
7.2.8. Assessment of the impact on aquatic environment 108
7.3. Solid Waste from the activities 108
7.3.1. Current Conditions 108
7.3.2. Solid Wastes By Planned Operations 109
7.4. Impact of Electromagnetic Fields, Noise and Vibration 113
8. RISK ASSESSMENT OF PLANNED ACTIVITIES ON HUMAN HEALTH 115

8.1. Risk Assessment of Proposed Activities on Human Health....115
8.2. Assessment of non-carcinogenic risk....115
8.3. Assessment of Carcinogenic Risks....119
9. ASSESSMENT OF IMPACT ON ENVIRONMENT DURING THE CONSTRUCTION 121
9.1. Construction Work....121
9.2. Air Pollution During Construction Work....122
9.3. Noise During Construction.....126
9.3.1. Noise Estimation....126
9.3.2. Impact on Population....127
1.1. 127
9.3.3. Vibration Impact During Construction....128
9.4. Assessing Impact of Construction....129
10. PUBLIC HEARING....130
10.1. General Schedule....130
10.2. Public Announcements....130
10.3. Public Discussion....131
10.4. Public Comments....132
10.5. Conclusions....133
11. COMPREHENSIVE MEASURES FOR PROVIDING NORMATIVE CONDITION OF THE ENVIRONMENT....135
11.1. Air Pollution Mitigation Measures....135
11.1.1. Odor Removal....135
11.1.2. Air Scrubber....135
11.1.3. Electric Filter....135
11.2. Aquatic Pollution Mitigation Measures....135
11.2.1. Sewage treatment facilities of car washes and industrial wastewater treatment facilities for wash units and motors....135
11.3. Solid Waste Disposal....136
11.3.1. Ashes....136
11.3.2. Other Wastes....137
11.4. Protective Measures During Construction....140
11.4.1. Air Pollution....140
11.4.2. Water....141
11.4.3. Noise....141
11.4.4. Vibration....141
11.4.5. Protection from electromagnetic field during construction works....143
11.4.6. Solid Waste....143
11.4.7. Soil....144
11.4.8. Accidents....144
11.4.9. Measures to create favorable living conditions for the population in the construction area.....144
11.5. Sanitary Protection Zone....145
Constructions....146
I-II....146
I-II....146
Buildings....146
11.6. Emergency situations....147
12. ENVIRONMENTAL MONITORING PROGRAM....147
12.1. Institutional Setup....147

12.1.1. Atmospheric Air Quality Monitoring....148
12.1.2. Water Quality Monitoring....148
12.1.3. Solid Waste Monitoring....149
12.2. Proposals of Normal Maximum Permissible Emission....149
12.3. Air Quality Monitoring....150
12.4. Monitoring Quality of Aquatic environment....152
12.5. Groundwater monitoring....154
12.6. Monitoring of Solid Waste....154
12.7. Construction Stage Monitoring....156

Appendix A: Reference Materials for EIA
Appendix B: Estimation of Pollutant Emissions by Sources For Ambient Air Concentration
Appendix C: Emission Estimation by Substance
Appendix D: Proposed Maximum Allowable Emission in Atmosphere
Appendix E: Construction Machinery and Estimated Emissions
Appendix F: OND -86
Appendix G: Public Hearing Records

Abbreviations

BOD	Biological Oxygen Demand
BAS	Bortnicheskaya Aeration Station
CV	Calorific Value
COD	Chemical Oxygen Demand
CHP	Cogeneration System
C1	Component 1
C2	Component 2
C3	Component 3
C4	Component 4
C5	Component 5
C6	Component 6
C7	Component 7
C8	Component 8
C9	Component 9
C10	Component 10
CD	Conceptual Design
FBI	Conventional fluidized bed incinerator
DSSE	Department of Sewerage System Exploitation, KVK
D	Depth
DBO	Design Build and Operate (Contract)
Dia.	Diameter
DO	Dissolved Oxygen
DS	Dry Solid
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EU	Europe Union
EOI	Expression of Interest
FOG	Fat, Oil & Grease
F/S	Feasibility Study
FY	Fiscal Year
GIS	Geographic Information System
GDP	Gross Domestic Product
HICC	Head Information and Computing Centre
IL	Ignition Loss
IEE	Initial Environmental Examination
IFRS	International Financial Reporting Standards
JICA	Japan International Cooperation Agency
JST	JICA Study Team
KCSA	Kiev City State Administration
KIP	Kyivinzhproekt Institute of PJSC Kyivproekt
kWh	kilowatt-hour
lpcd	Liter Per Capita Per Day
MPC	Maximum Permissible Concentration
MPD	Maximum Permissible Discharge
MPE	Maximum Permissible Emission
MPL	Maximum Permissible Level
M&E	Mechanical & Electrical
MWh	Megawatt-hour
MoENR	Ministry of Ecology and Natural Resources
MoEDR	Ministry of Economic Development and Trade
MoF	Ministry of Finance
MoJ	Ministry of Justice

MLIT	Ministry of Land, Infrastructure and Transportation
MoRDCH	Ministry of Regional Development, Construction and Housing and Communal Services
M/D	Minutes of Discussion
MLSS	Mixed liquor suspended solids
NCSPUR	National Commission for the State Public Utilities Regulation
NTU	Nephelometric Turbidity Unit
NRW	Non Revenue Water
N/A	Not Available
N/D, N.D.	Not Detectable
ODA	Official Development Assistance
OJSC KVK	Open Joint Stock Company KVK
O&M	Operation & Maintenance
PFBI	Pressurized fluidized bed incinerator
PCC	Project Coordination Committee
PD	Project Director
PEA	Project Execution Agency
PIA	Project implementation agency
PIU	Project implementation unit
KVK	Public Joint Stock Company “KyivVodokanal”
PJSC KVK	Public Joint Stock Company KVK
PPP	Public Private Partnership
P/S	Pumping Station
SPZ	Sanitary Protection Zone
SV	Sludge volume
SVI	Sludge volume index
SRT	Solid retention time
STEP	Special Terms for Economic Partnership
SCADA	Supervisory Control and Data Acquisition
SS	Suspended Solids
TOR	Terms of Reference
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
T-P	Total Nhosphorus
T-N	Total Nitrogen
TSS	Total Suspended Solids
UAH	Ukrainian Hryvnia
UFW	Unaccounted for Water
UNDP	United Nations Development Programme
US$, USD	United States Dollars
VAT	Value Added Tax
VVVF	Variable Voltage Variable Frequency
VSS	Volatile Suspended Solids
WWTP	Wastewater Treatment Plant
WTP	Water Treatment Plant
W	Width
WTP	Willingness-to-pay
WB	World Bank
WHO	World Health Organization

1. ABSTRACT

This EIA section is carried out as part of the project captioned "Reconstruction of wastewater treatment facilities and construction of technological line for processing and disposal of sludge in the Bortnychi WWTP" developed by the Subsidiary Enterprise "Institute Kyyivinzhproekt" of LLC "NVPI Kyivproekt" in 2014.

The objectives of this section are assessment of environmental impact of the design decisions and identification of ways and means of normalizing the environmental conditions and ensuring environmental safety requirements as the result of the planned activities and operation of facilities.

the main objectives of EIA are:

- assessment of the current conditions of the area and site where the construction activities are planned;
- determination of list of possible hazardous impacts(hereafter - impacts) and zones of impact on the environment;
- determination of scope and impact intensity of the project activities on the environment in normal and emergency conditions;
- prediction of environmental changes in accordance with the list of impacts;
- definition of complex of measures aimed to prevent or limit the impact on the environment, which is necessary for compliance with environmental legislation and regulations;
- determination of residual impacts and acceptability of economic activity from the environmental point of view.
- preparation of "Statement of intent";
- preparation of "Statement of environmental impacts."

Obtaining heat from fossil fuels, construction of sewage networks and treatment facilities are included into the "List of environmentally hazardous facilities", hence, according to paragraph 1.7 of DBN[1] A.2.2-1-2003, "Structure and content of EIA documents", the EIA section for the project captioned "Reconstruction of wastewater treatment facilities and construction of technological line for processing and disposal of sludge in the Bortnychi

[1]DBN is Ukrainian for State Construction Regulation

WWTP, " is implemented in full scale in accordance with the requirements of Section 2 of the mentioned DBN.

2. LEGAL AND REGULATORY FRAMEWORK

2.1. Policies, Laws and Regulations Related to Environmental and Social Considerations

2.1.1. Environmental Policy

There are several legal instruments on the environment at the national and local levels, such as:

- Law of Ukraine "On the Fundamentals (Strategy) of the State Environmental Policy of Ukraine for the period till 2020."
- National Environment Action Plan for 2011-2015 (Resolution of the Cabinet of Ministers of Ukraine of25 May 2011 № 577-p).
- Kyiv General Plan

The Law of Ukraine "On Fundamentals (Strategy) of the State Environmental Policy of Ukraine till 2020" was adopted in 2011, stating that the objective of the national Environmental Policy is to stabilize and improve the environment in Ukraine by integrating environmental policy into socioeconomic development of Ukraine, to ensure environmentally safe life and health in order to introduce an environmentally balanced system of natural resources and preservation of natural ecosystems.

The national Environmental Policy aims to achieve the following strategic goals:

- Raise public environmental awareness;
- Improve the environment and increase the level of environmental safety;
- Achieve environmental conditions that would be safe for human health;
- Integrate of environmental policy and improve the integrated environmental management system;
- stop the loss of biodiversity and landscape diversity, and establish ecological networks;
- ensuring environmentally sustainable nature use.

The main tools of the national Environmental Policy are:

- cross-sector partnership and stakeholder engagement;
- assessment of impact of environmental policies, programs and plans;
- improvement of the system of licensing in the field of environmental protection;

- environmental expert review and impact assessment of the environmental objects of expert review analysis of the environment;
- environmental audit, environmental management systems;
- environmental insurance;
- technical regulation, standardization and reporting of environmental protection, management and safety;
- legislation in the sphere of environmental protection;
- education and scientific research, support, development and implementation of national environmental policy;
- economic and financial mechanisms;
- environmental monitoring and control in the sphere of environmental protection and safety;
- international cooperation in the field of environmental protection and providing the protection of environment.

The national environmental policy sets out many strategic goals. One of the goals of improving the environmental situation and security is "Rehabilitation of the existing and construction of new municipal sewage treatment facilities to reduce the level of pollutants in water by 15 percent (primarily organic matter, nitrogen and phosphorus compounds), and reduction in under-treatment of wastewater by 20 percent by 2020."

To achieve this, the national Environment Action Plan for 2011-2015 (Cabinet of Ministers of Ukraine of25 May 2011 № 577-p) was approved in 2011.

According to the national Environment Action Plan for 2011-2015, approved in May 2011, the following measures will be taken related to wastewater treatment:

- development and approval of guidelines and their implementation in economic activity, introduction of environmentally safe technologies (systems for wastewater treatment, water supply, protection of water and land resources, energy conservation, use of alternative energy sources, environmentally safe manor farming, etc.);
- construction and reconstruction of municipal wastewater treatment facilities.

2.1.2. Laws and Regulations on Environmental and Social considerations

There are a number of codes, laws, ordinances and regulations regarding environmental protection, EIA and sanitation.

The main legislations listed below:

- Water Code of Ukraine (June 6, 1995)
- Land Code of Ukraine (October 25, 2001)
- Forest Code of Ukraine (January 21, 1994)
- Law of Ukraine "On environmental protection (June 25, 1991)
- Law of Ukraine "On protection of ambient air (16 October 1992)
- Law of Ukraine "On environmental expert review" (February 9, 1995)
- Law of Ukraine "On waste" (March 5, 1998)

2.1.3. Law of Ukraine "On Environmental Protection (June 25, 1991)

The “Law on Environmental Protection” was adopted in 1991 before the collapse of the Soviet Union. The task of the legislation on environmental protection is to regulate relations in the sphere of protection, use and renewal of natural resources, providing environmental safety, preventing and eliminating negative impact on economic and other activity on the environment, conserving natural resources, genetic stock of wildlife, landscapes and other natural systems, unique natural areas and objects related to historical and cultural heritage.

Environmental expert review is mandatory in the legislative, investment, administrative and other activities that may have impact on the environment. The following is the subject to environmental assessment by experts:

- projects for model development and distribution of productive forces, development of sectors, general plans of settlements, regional planning patterns and other documents created prior to planning and design;
- feasibility study and calculations, construction and renovation projects (expansion, technical re-equipment) of enterprises and other facilities which could adversely affect the environment, regardless of their form of ownership and jurisdiction;
- draft acts and documents relating to the instructions, procedures, and technical standards that regulate economic activities that adversely affect the environment;
- documents relating to the development of new machinery, materials and substances, including those acquired abroad;
- materials, substances, products, economic solutions, systems and tools, the introduction or sale of which could result in violations of environmental safety and impact the environment or pose a threat to human health environmental assessment may also be required for environmentally dangerous facilities and systems in operation, including those serving military and defense purposes.

The Law also establishes the environmental rights and responsibilities of the citizens of Ukraine, regulates standardization and normalization of environmental protection issues and establishes liability for violation of environmental protection legislation.

2.1.4. Law on urban development (12 March, 2011)

The law establishes legal and organizational framework for urban planning and aims to ensure the sustainable development of territories based on various public and private interests. The law provides that zoning and development is an activity of state bodies, local authorities, legal entities and natural persons, which entails:

- Prediction of territory development;
- Ensuring efficient movement of people and determining areas for sustainable development of the territories;
- Justification of allocation of land for certain purposes;
- Mutual coordination of state, community and private interests in zoning and development;
- Defining and understanding the relative position of residential, industrial, recreational, environmental, historical, cultural, and other areas and regions;
- Determining modes of development for areas where urban activities are foreseen for alterations;
- Prepare urban design documentation for planning and construction of facilities;
- Reconstruction of existing buildings and territories;
- Conservation, creation and renewal of recreational, environmental and health areas and objects, landscapes, forests, parks, mini parks and individual sites of vegetation;
- Maintaining of the urban planning cadaster;
- Control in the sphere of urban planning.

According to Article 32 of the Law, all construction projects are classified by category of complexity I, II, III, IV and V, depending on the complexity of architectural and building concepts and/or utilities. Construction of facilities of a certain degree of complexity is determined in accordance with state building codes and standards based on the importance of class of the construction facility.

2.1.5. Regulations on EIA

EIA is made in the manner prescribed by the national standard DBN (State Building Standards) A.2.2-1 – 2003. The structure and content of environmental impact assessment (EIA) for design and construction of enterprises, buildings and structures", approved by the Order № 214 of Ministry of Construction and Architecture of Ukraine on15.12.2003. According to SBS A.2.2-1 - 2003, project design documentation must include an EIA report. The EIA report must be prepared for new construction, expansion, reconstruction and modernization of industrial and civil facilities. It is mandatory for state, local and regional authorities, enterprises, institutions and organizations regardless of ownership form and departmental affiliation, as well as individuals working in Ukraine. More detailed references are included in Appendix A.

Preparation of EIA is mandatory for activities and facilities that are very dangerous, and is approved by Cabinet Resolution of Ministers of Ukraine on July 27, 1995 No. 554, which was amended on June 6, 2011 № 630. The construction of sewer systems and treatment facilities "is included in the list and EIA is required for this project.

The structure and content of the EIA report are:

- Grounds for EIA;
- Physical and geographical characteristics of the construction area of the designed facility;
- General description of the designed facility;
- Impact assessment of the proposed activities on environment (climate and micro-climate, air, geological environment, water, soil, flora and fauna, reserves);
- Assessing the impact of proposed measures on social protection;
- Assessing the impact of the proposed measures on the anthropogenic environment;
- Comprehensive measures to ensure legal and regulatory frameworks;
- Assessment of environmental impacts during construction (ambient air, noise, and other r physical impacts, surface and underground water, soil, flora and fauna, conditions of human life, cultural and historical heritage, techno genic facilities).
- Statement on environmental consequences of activities.

2.1.6. Regulations for Public hearings

There are three regulations relating the public hearings as follows:

- Decree № 168 of Ministry of Environment "On approval of the public participation in decision-making for environment", 18 December 2003;
- Cabinet of Ministers of Ukraine № 771 "On approval of involving the public in discussions on decisions that may affect the environment" 29 June 2011;
- State Environmental Expert review and issues of involving the public in order to implement the ecological rights of free access to information on environment;

The stakeholders/participants of public discussion are the authorities, enterprises, institutions and organizations including form of ownership; entrepreneurs that are planning to transact business, the media and interested public.

Public discussions must include:

- Informing the public about the beginning of the project and opportunity to participate in it;
- Public access to the draft decision of documents on which the decision is made, and other relevant information;
- Allowing the public to submit comments/suggestions when deciding to participate in public hearings and other forms of public debate;
- Review of submitted comments/suggestions;
- Specialists are required to explain to the public about registration or rejection of submitted comments/suggestions;
- Providing public review of the decisions.

The types of decisions, which require public participation, include:

- Development of international, national, regional, local and other regional programs and local plans and other documentation;
- Preparation of draft laws and regulations;
- State Environmental Expert review of the EIA for hazardous facilities and activities;
- Documents on use of natural resources, activities related to environmental pollution, management of hazardous substances, waste and its placement,
- Costs related to the implementation of environmental measures through environmental protection.

For a project in which the activities and facilities are of high environmental risk, public discussion is conducted in two stages: (I) - in preparation of materials for the evaluation of environmental impact regarding the facilities that are highly dangerous, (II) - State Environmental Expert review.

The forms of public participation in decision-making on issues that have or may have an adverse effect on the environment are:

- Expert, working groups and commissions, committees to develop programs, plans, strategies, projects, regulations, risk assessment;
- Work within the framework of state environmental expert review committees;
- Public discussion during parliamentary hearings, conferences, seminars, round tables, discussion of sociological research, public meetings, etc.;
- Organization of public environmental expert review;
- Discussion of use of different alternatives during the development of the project EIA documents;
- Appeal to authorities on current issues relating to the protection of the environment with suggestions and recommendations to address the m in a manner prescribed by the law "Procedure of involving the public in the discussion regarding decision-making which may affect the state of the environment (Cabinet of Ministers Regulation No.771 of June 26, 2011)";
- Discussions in media about the environmental issues;
- Other forms provided by legal acts and regulations of Ukraine.

2.1.7. Process of Preparing EIA, Review and Approval

Table 2-1 below shows the EIA development procedure, which should match the overall technological schemes of the construction investment process. The project is in the conceptual design phase (CDP) and EIA reports are prepared.

Table 2-1 Investment Process of Construction

No.	Phase of design and construction	Phase of EIA
Making decision on construction by the investor		
Pre-study research		
1.	Preparation of initial data on the construction of the planned facility, definition of the program, investment intentions, needs for raw materials, energy and personnel, etc.	Preparation of the Statement of Intent. Preliminary assessment of impact of the design facility on environment.
2.	Creating options for designed facility placement depending on environmental conditions and site development	Preparation of the Statement of Intent.

3.	Preparation and approval of tasks for the development FS and conceptual design (CD)	Making the task for designing, EIA as part of the task of development FS and conceptual design (CP).
4.	Design of FS and CD to the extent prescribed by the rules.	Development of EIA in FS and CD. Public hearings and preparation of statements of environmental impact.
5.	Approval and adoption of FS and CD.	Comprehensive state expert review and approval of EIA in FS and CP. Transfer of the environmental impact statement to the local government.
Design		
6.	Preparation and coordination of tasks for the development of the project (technical draft)	Preparation of tasks for the development of EIA as part of project for the development (draft) to reflect changes in the structural considerations against those who made investments in FS, CP, or a change in the urban development situation.
7.	Development of project (technical draft)	Comprehensive EIA, if it was not done in the previous step or adjustment according to the draft of EIA
8.	Approval and adoption of the project	Comprehensive state expert review and approval of EIA in accordance with applicable law.
Construction		
9.	Development of working documentation of the project	Regulation of EIA in case of change of production technology and construction work, which affects the environmental conditions
10.	Construction of facilities	Obtaining construction permit. Implementation of measures set out in EIA.
Operation		
11.	Development of design capacity and analysis of project	Assessment of the effectiveness of protective measures in accordance with the materials of EIA, regulator of EIA and conduct of monitoring, if necessary.

Process of EIA from preparation to approval is shown in the Figure 2-1 below.

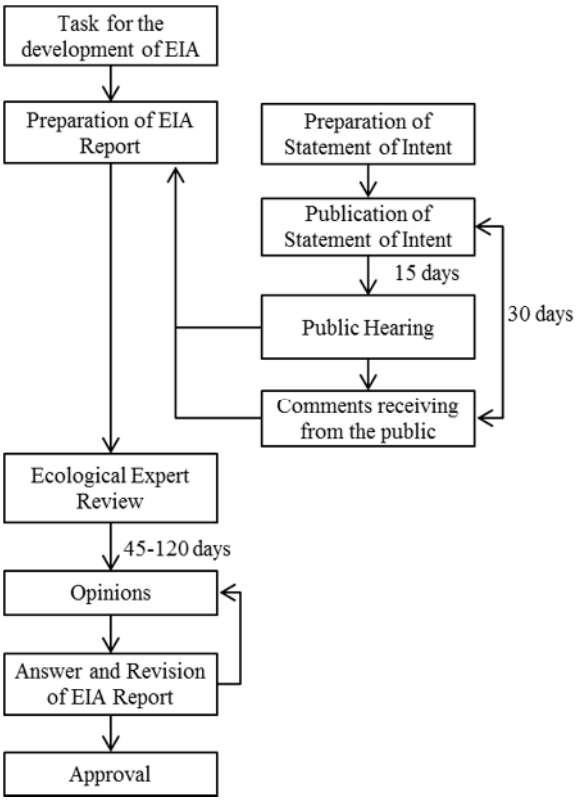


Figure 2-1 Flow of EIA

Public hearings should be organized in preparation of EIA report. The public hearing process is as follows:

- Preparation and notification,
- Public hearings
- Follow-on For Public hearing

2.1.8. Preparation and Notification

To begin consultations with the public, the organizer must inform the public about:

- Summary of Statement of Intent to carry out certain activities;
- Brief description of the project concept, construction, installation or other activity which has or may have an adverse impact on the environment;
- The name of the body that makes decisions and the address where one can access the documents based on which the decision will be made, and additional information upon request;
- Timeframe for comments;
- Decision-making process, including the time and place of public hearing, etc.

The organizer must publish a notice of public hearing to the public. The methods of notification are: through the media (radio, television, newspapers, and Internet system), by sending an email invitation, placing advertisements in public places and information centers. Public hearings are held within 15 days after public notice of the set of documents containing assessment of environmental impact.

2.1.9. Public hearings

Public hearings begin on draft decisions of the Customer. The report should note the following issues:

- Content of the draft decision on planned activities;
- Possible negative impact on the environment;
- Measures to prevent and reduce the impact;
- Summary of draft decision;
- The content of comments and suggestions of public who participated in Public hearings;
- Other information regarding the draft decision.

During the Public hearings, the public has an opportunity to freely express their thoughts, comments, suggestions and recommendations verbally and in writing. The organizer has to answer the public verbally at the public hearing or in writing after they end.

2.1.10. After Public hearings

Comments/opinions from the public may be submitted to the organizer within thirty days from the date of publication of Public hearings. The organizer prepares responses to comments/suggestions received from public and information on registration or reasons for refusal and publishes these materials in the media that cover the territory, as well as placement on the official website of organizer of the Public hearings.

3. GROUNDS FOR EIA

3.1. General Background

3.1.1. Political Decisions

The project was initiated by the cabinet resolution in 2012, i.e., “Resolution of Cabinet of Ministers of Ukraine № 933 of ^# 3.10.2012: On some issues of construction and cost estimation documents for Bortnychi WWTP in Kyiv", followed by “Order of Cabinet of Ministers of Ukraine № 279 of 17.05.2012: On the allocation of funds for 2012 emergency environmental protection measures for the construction and cost estimation documents for sewerage facilities". The nodal ministry of the Project, the Ministry of Regional Development, Construction, Housing and Utility Services followed the cabinet order by issuing “Decree of Ministry of Regional Development, Construction, Housing and Utility Services of Ukraine № 527 of 16.10.2012: On organization of implementation of the Order by Cabinet of Ministers of 03.10.2012 № 933" then to appoint KVK as the implementing agency by “Agreement No. D-15/266-2012 of 16.10.2012 regarding the delegation of functions of customer of implementation in 2012 of urgent environmental measures for the construction and cost estimation documents for Bortytskaya WWTP in Kyiv, concluded between PJSC "AK" Kyivvodokanal" and Ministry of Regional Development, Construction, Housing and Utility Services of Ukraine”, followed by the city of Kiev with “Order of Kyiv City State Administration (KSCA) № 1549 of 07.11.2008: On Approval of "Feasibility study of the reconstruction of wastewater treatment facilities and sewage construction process line for processing and disposal of sludge in Bortnychi WWTP", “Ordinance of the executive body of Kyiv City (Kyiv City State Administration) of 10.02.2012, № 228: On some issues of reconstruction of Bortnychi WWTP.” The task of feasibility study as well as EIA are defined by “Task of designing the reconstruction of sewage treatment facilities and sewage construction of production lines for processing and disposal of sludge of Bortnychi WWTP, approved by representative of KSCA and agreed by representatives of Ministry of Regional Development, Construction and Housing and Utility Services of Ukraine of 18.10.2012, ” and “Terms of reference (Appendix to "Task for design of reconstruction of wastewater treatment facilities and construction of technological line for processing and disposal of sludge in Bortnychi WWTP), approved by decision of Technical Council of PJSC "AK" "Kyivvodokanal" and Chairman of Board of PJSC "AK" "Kyivvodokanal" of 18.10.2012.

3.1.2. Rationale of Project

The main problem for proper functioning of the BAS is caused by the accumulating sludge at the disposal sites. After the ban on the reuse of dried sludge for agricultural fertilizers, the loss of outlet leads to endless accumulation. More than 97% of the excess sludge transferred to the disposal site is comprised of water content which will accumulate to overflow the embankment of the disposal sites instead of returning to the BAS to be remixed with the incoming raw sewage. Given high levels of SS levels and BOD, the return sludge deprives the processing capacities of sewerage treatment facilities. While the current volume of sewerage is less than one million cubic meters per day, all the three sewerage treatment trains are operated to cope with high levels of nitrogen and potassium contained in the return sludge.

Bortnychi WWTP of PJSC "AK" "Kyivvodokanal" is the only wastewater treatment facility of Kyiv. All domestic sewage, as well as industrial effluent after preliminary treatment at the enterprises, is treated at the station. Bortnychi WWTP is a complex of engineering structures, equipment and communications, designed for full biological wastewater treatment.

Sewage from the right bank of the city by means of pressure and gravity collector is pumped to the facilities of first block of BAS (to the pumping station of first line); sewage from the left bank of the city - by gravity Novo-Darnytsky collector.

Most of the sewage from the right bank of the city is pumped to the facilities of second and third blocks by means of Right Bank pumping station, and from the residential areas Kharkivsky and Poznyaky - by sewage pumping station "Poznyaky".

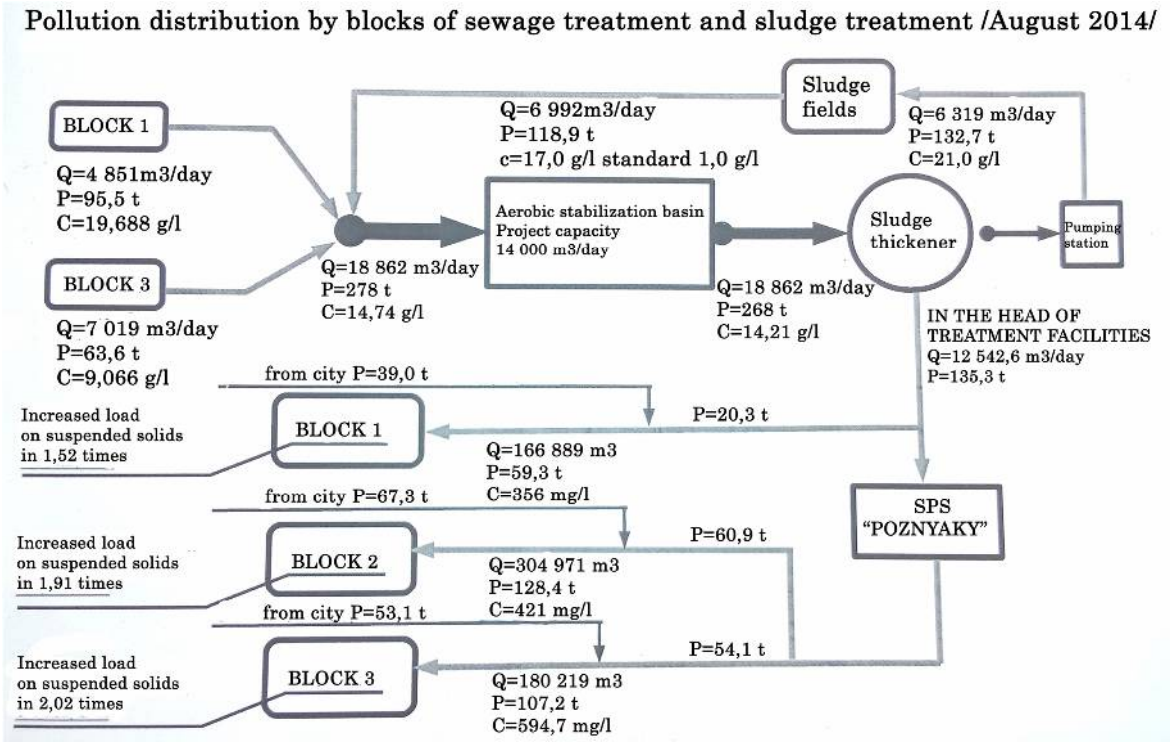
Analysis of available information on the functioning of BAS testifies possible negative consequences of its further operation without capital repairs. The main problem is the current practice of disposing sludge which necessitates re-processing of excess water from the disposal sites at the BAS sewerage treatment facilities. The re-injection of returned sludge water with high concentrations of contaminants impose heavy load on processing capacities of the sewage treatment facilities while requiring ever growing area needs for the disposal of sludge.

Another problem is physical wear and obsolescence of the BAS faculties built during 1960s. Buildings, pipes, pumps and other equipment of Block 1 are unacceptable for further operation, and some of those are in emergency situation. Kiev City Administration instructed not to operate Block 1 facilities, however, due to the shortage of treatment capacity, the operation of Block 1 cannot be stopped. Most of the effluent standards are satisfied but some

parameters such as SS, total nitrogen and phosphorus exceed the effluent standards due to the overload imposed by the reinjection of sludge water.

The sludge generated from the treatment process is treated at the sludge fields located outside of the BAS and pilot sludge platforms within the BAS. The total area of sludge fields outside of BAS is 272 ha and they are located in Boryspil district of Kiev region (7 - 14 km away) consist of sludge fields No. 1, No. 2 and No. 3. In 1985, by the resolution of Boryspilska sanitary and epidemiological station, The transportation of dried sludge from sludge fields was prohibited due to the high content of heavy metals, which made it impossible to use those in agriculture as organic and mineral fertilizers. Therefore, during the last 20 years, transportation of dried sludge from sludge fields has practically not been done and sludge fields turned into sludge storage grounds. Actual volumes of sludge on the fields exceed the projected ones by more than three times (as of 2012, actual volume of dried sludge amounts to more than 10 million m^3 with the design volume of 3 million m^3). Excess sludge is stored in the sludge fields by heightening the embankments. However, there is no free area reserved at sludge fields at present. Excess disposal has caused their leaking at some overflowing platforms and sludge flow to adjacent territories. Further use of existing sludge fields will cause their overfilling, breakage of dams, spill to agricultural fields and adjacent territories. Within next 5-7 years, it will be impossible to send sludge from BAS to the sludge field and to treat Kyiv wastewater. In such a case, non-treated sewage will simply be discharged into the Dnipro.

A high water content of transferred sludge, nearly 97%, and added precipitation in the sludge field necessitates recycling of water overflow to the sewerage treatment process of BAS. Figure 3-1 is the estimated flow of sludge to the sludge fields and then re-mixing to the wastewater treatment facilities. The returned sludge is fed to the sludge aeration tank. After separation of water at the sludge thickener, the separated water is fed to the inlet of sewage for all Block1 to 3. Under the current condition, the returned sludge contain as much as 90% of the original sludge content, making it necessary to process sludge go through sewerage treatment process five to ten times in theory. In practice, returned sludge poses processing load no less than 30% of overall treatment. Moreover, the current stockpiling of sludge in open fields poses environmental risks of soil/groundwater contamination with potential breakage of embankments. Thus, the Project itself aims at improving environmental impacts on water, waste disposal and soil. Nevertheless planned introduction of incineration process of sludge will have negative environmental impacts of emitting more substances into the air and generate ashes. The positive and negative impacts need to be quantified and studied.



Source: KVK
Note: P represents dry substances within sludge

Figure 3-1 Estimated Sewerage Treatment Load of Sludge in Cycle

The proposed project is composed of two major sub-projects: 1) introduction of incineration process of sewage sludge and 2) reconstruction of the sewage treatment facilities. Separated sludge from sewage treatment was originally recycled for fertilizer until the practice was banned in 1985 due to heavy metal contamination and radioactive material concern. At present, sludge is sent to the sludge field for permanent stocking. Sludge accumulated over the last three decades has nearly reached the limit of storage capacity. Moreover, the high dry substance contents in the returned water from the sludge fields have led to the degradation of sewerage treatment capacities, necessitating the BAS to operate full three treatment blocks even though one to two blocks are required under normal operating conditions.

The revision provides for the following changes in the design and cost estimation documentation:

1. Sludge treatment is assumed without prior digestion. As a result, the entire line of production, storage and combustion of gas in cogeneration plants for the production of heat and electricity is excluded from the project.
2. The use of equipment manufactured in Japan in much of the technological line for processing and disposal of sludge (Components 2 and 3) is provided.

3. The number and type of furnaces for sludge incineration is changed, namely the use of pressurized fluidized bed incinerators is provided.
4. Change in air deodorization technology for the line of disposal of sludge is changed to incineration of hazardous substances in the incinerator.

As a result of the project revision and the adoption of new technological solutions, the project will include the following facility characteristics

- Emissions of pollutants (g/s and t/year): decrease 4.2168 g/s and 24.0653 tons/year respectively in the whole facility reconstruction compared to previous design decisions.
- The amount of water consumption remains at the same level.

Amount and generation of heat and electricity:

- Heat consumption - 14.3 MW
- Thermal power generation - 9.3 MW
- Electricity consumption - 42.3 MW
- Production of electricity - 1.5 MW

3.1.3. Existing Production Structure of BAS

The current setup of the BAS facilities composed of 1) pumping stations, 2) main treatment facilities, 3) auxiliary facilities and 4) sludge disposal fields.

Pumping stations;

- First rise pumping station;
- PS "Pozniaky";
- Section of treatment facilities of Block 1;
- Section of treatment facilities of Block 2;
- Novo-Bortnychi station of aeration (a. k. a. Block 3);
- Section of sludge treatment;
- Section of aerobic stabilization of sludge;
- Section of natural sludge dewatering;

- Section of servicing collectors;
- Chemical and bacteriological laboratory;
- Section of boilers and heating systems (fuel oil composition);
- Section of technical maintenance of power equipment;
- Section of repair and technical maintenance of facilities and structures (section RDB);
- Section of gardening and landscaping.

Main treatment:

- Acceptance and purification of domestic sewage, industrial sewage of Kyiv after pre-treatment at local sewage facilities of industries, in compliance with norms of discharging into municipal sewers;
- Supply of sewage sludge after pre-treatment (digestion or aerobic stabilization), for their dewatering in natural conditions and providing accumulation and storage at sludge fields of the section of natural sludge dewatering facilities;
- Thermophilic digestion of organic substances that are part of raw sludge and excess sludge;
- Output of return water to the river of Dnipro.

Auxiliary functions:

- Heat production (fuel - natural gas, fuel oil);
- Production air-blasting stream;
- Reception, storage and dispensing petroleum products (fuel oil);
- Laboratory and analytical work (chemical, physical and chemical, sanitary-microbiological and radiological studies);
- Repair works (mechanical, electrical, thermal, plumbing, motor, construction).

Sludge disposal fields:

- Storage of excess sludge

BAS functioning will cause the following types of environmental impact:

– Atmospheric air - air pollution by emissions from boilers, ventilation system of technological equipment of the WWTP (screening department, sand catchers, primary sedimentation tanks, aeration tanks, secondary sedimentation tanks), ventilation system of industrial facilities, DVZ vehicles;

– Water environment - sending treated sewage into the river of Dnipro, reusing water for washing special vehicles, water supply for facility;

– Soils - violation of soil cover with excess sludge.

3.1.4. Process Scheme of Bortnychi WWTP

The sewage that comes to the facilities of Block 1 first comes to the receiving channel of the screening department of the First Rise pumping station, and then to the grades with mechanical screens. The waste left on the screens, is collected by a transporter into special storage hopper and transported to the plant "Energiya" for incineration. Sewage is pumped to the screens of the screening department No. 1 by means of pumps, installed in the engine room of the 1st rise pumping station, and then to the sand catchers.

From sand catchers, sewage is moving by gravity into all facilities. Wastewater treatment is performed in the following sequence:

- In sand catchers, heavy mineral impurities are separated (mainly - sand);

- Primary sedimentation tanks retain roughly dispersed mineral suspended solids, undissolved organic impurities, floating substances, fats;

- Clarified water, containing finely dispersed suspension, soluble and colloidal organic matter, is forwarded to aeration tanks, where the biological oxidation of organic matter by activated sludge at intense aeration of liquid with air takes place;

- Sludge mixture after aeration tanks is forwarded to the secondary sedimentation tanks, where the sedimentation of active sludge takes place. By means of sludge suckers, sludge is continuously removed from the sedimentation tanks and pumps, located in the pumping stations of aeration tanks, returns to the aeration tanks:

- Biologically treated water from the secondary sedimentation tanks enters the outlet channel, and from there - to the main channel.

Treatment of wastewater that comes to the facilities of the second and third blocks of BAS, is done in the same sequence as at thee first line.

Discharge of treated wastewater after Blocks 2 and 3 facilities is made through side spill weir to the main channel, where it is mixed with the treated wastewater that comes from Block I. A mixture of treated returned wastewaters in the main channel is assigned to the pumping station Bortnychi-Vyshenky, and then through the scattering channel to Dnipro River. The contaminants remaining during wastewater treatment are removed as follows:

- The waste left on the screens is removed with mechanized rakes and by conveyors and is sent into storage hopper from which it is daily reloaded into trucks and transported to the incineration plant "Energiya";
- The sand left in sand catchers is sent by means of hydraulic elevators to sand areas, where it is dehydrated and then exported by means of mechanization;
- Raw sludge (insoluble organic impurities and coarsely dispersed mineral substances) and fatty floating substances, left in primary sedimentation tanks, is pumped by pumps installed in pumping stations of raw sludge to the digesters for digestion;
- Excess activated sludge is removed for treatment from facilities to the aerobic stabilizers.

In aerobic stabilizers (facilities similar to aeration tanks) the process of oxidation of organic matter by microorganism aerobes takes place in the presence of oxygen. Active sludge is growing rapidly, developing in nutrient substrate and then it oxidizes itself.

3.1.5. Characteristics of Sewage Sludge of Bortnychi WWTP

The section of aerobic stabilization of sludge operates "AUTOFLOC" equipment made by "KEM-TRON" company for intensification of process of thickening the stabilized sludge by means of flocculants. In the digesters at thermophilic regime under anaerobic conditions occurs digestion of organic substances that are part of raw sludge and excess active sludge. In the process of anaerobic digestion of sludge, it is also stabilized and sanitary disinfected. Digestion is accompanied by emission of gas - methane, to be collected by gas caps, gas chamber, gas pipes and gasholders are used.

Stabilized sludge is supplied to the sludge thickener, from where it is sent to the reservoir, and then pumped to the sludge fields or pioneer sludge sites for dewatering. On the sludge fields occurs sludge dewatering. Supernatant water, formed during sludge dewatering, by means of pumps is pumped to the facilities of block two or for the processing into aerobic stabilizers. At least 12,000 m^3 of sludge with 97-98% water content is generated at the station daily. Due to the absence of any technology of effective utilization of sludge at the station (the

facilities designed in the 1950's did not provide any), the only way of processing sludge is by pumping it to the sludge fields for natural dewatering. Sludge fields of Bortnychi WWTP (total area: 272 ha) are specially designed areas on natural or artificial base, where sludge dewatering occurs.

In Bortnychi WWTP, sludge fields in operation are fields No. 1, 2 and 3, as well as pioneer sludge fields, located on the territory of aerobic sludge stabilization unit. Sludge fields No. 1 - scale of sludge storage areas- 54.95 ha, total volume at design filling of 1.5m is 761, 045 m^3, in operation since 1965.

Sludge fields No. 1 consist of two parts:

a) the first part - 4 cascades with7 areas in each cascade with a natural bottom (sandy and sandy clay soils). Total area is 27.4 ha.

b) the second part - reconstructed - 48 areas with asphalt bottom and horizontal drainage). Total area is 27.5 ha.

Sludge fields No. 2 - total area is 65.0 ha; a total volume at the design filling of 1.5m is 985,100 m3. In operation since 1976, they consist of 12 cascades, 7 areas in each.

Sludge fields No. 3 (additional) - the total area is 80.85 ha, total volume at design filling at 1.5m is 1,265,648 m^3. Constructed and set for operation after the Chernobyl accident in 1986 for receiving contaminated sludge, the dams and bottom of sludge areas are covered with black plastic sheeting with 0.2m soil added to exclude drainage of sludge water. Pioneer sludge fields- 26 sludge fields with total area of 12.35 ha of artificial subsoil (asphalt) and horizontal drainage.

In the normal process of sludge dewatering on sludge fields, dried sludge and sludge backwash water, formed during the dewatering process, is sent for treatment to the head of treatment facilities.

3.2. List of Restrictions

The main urban restrictions of environmental, sanitary-epidemiological, fire safety, urban development and spatial nature include:

- Compliance with the limits of land allocation - design is made within the limits of land area of 429.85 ha, owned by the company under long-term lease;
- Impact on existing roads- Bazhana Avenue, mutual alleged harmful impacts on the design facilities and from it is missing; construction is planned outside the red lines and line of regulation development;
- Protection zones of underground utilities, including:

- underground cables "Ukrtelecom", protection zone 0.6m (DBN 360-92 ** ap. 8.1) - impact by construction is absent;
- water pipeline network protection zone 5m (DBN 360-92 ** ap. 8.1) - impact by project development is absent, regulatory distance is maintained;
- low pressure pipeline protection zone 2m (DBN 360-92 ** ap. 8.1) - impact on project development is absent, regulatory distance is maintained;

- Impact on the existing adjacent residential area (p. 3.45 *DBN 360-92 **); legal objections to the placement of BAS territory near the residential areas exist. Necessary to ensure compliance with sanitary and fire safety regulations regarding the requirements regarding the location of certain technological manufacturing sites, sewage treatment facilities, parking lots for temporary placement of cars;
- Sanitary protection zones of industrial enterprises: Bortnychi WWTP is designed to receive sewage amounting to 1,800 thousand m^3/day and in accordance with note 2 table. 8.4 p. 8.12 DBN 360-92 ** for structures for mechanical and biological treatment with sludge fields capacity over 500 thousand $m^{3/}$day regulatory SPZ of 1200 meters is confirmed. According to the letter of Ministry of Health of Ukraine № 05.01.03-45 of 18.01.2007 and № 05.03.02-07/36985 of 23.07.07 for Bortnychi WWTP there is a defined SPZ of 600m from the secondary sedimentation tanks and 900m from the primary sedimentation tanks BOS-1 considering the reconstruction of Bortnychi WWTP;
- geotechnical conditions of the construction site: geological structure of study area is typical for floodplain terraces of Dnipro. The surface of areas is usually raised by alluvium and soil adding, and is characterized by the absolute height of surface within 93.6 - 104.0m.

The area is located outside of the territory of special status of cultural heritage protection. Environmental restrictions and requirements are governed by the current laws of Ukraine in the field of atmospheric air, groundwater, and rational use of land resources.

3.3. Information on Relation of Public to the Planned Activity

The territory of the treatment facilities is located in the northwestern part of the village of Bortnychi, which is in the southeastern part of Kyiv. Notification of the interested public was made by publication of "Statement of Intent" and "Statement of environmental impacts of

planned activities" in the media (newspaper "Khreschatyk") as detailed in Chapter 10. KVK, along with Kyiv City prepared and held public hearings. The project materials included all comments and suggestions of experts and interested public. The materials of the project can be requested from the General Designer - Subsidiary Enterprise “Institute Kyivinzhproekt” of LLC “NVPI Kyivproekt” and the Customer. The Customer and General Designer have processed those appeals and offers from the interested public and proposed qualified answers. Most of the population supports this project due to its importance and the need to address the problem of sludge disposal.

4. PHYSICO-GEOGRAPHIC AND CLIMATIC CHARACTERISTICS OF THE PROJECT AREA

4.1. General Description of Project Area

The treatment facilities are located in the northwestern part of the village of Bortnychi in the southeastern part of Kyiv on the left bank of the Dnipro River. The existing facilities of Bortnychi WWTP are located on multiple platforms of land with total area of 429.85 ha.

The major technological facilities of BAS - Block 1 BAS along with additional facilities of "Kyivvodokanal" are located in area S = 38.3 ha, which is situated in the north of the village of Bortnychi and bounded on the north-west side of Kollektorna Street, from the north-east side - Avtoparkova Street. Relief is plain, vertical drop marks - 0.8 m.

Block 2 (area S = 35.0 ha) and Block 3 (area S = 36.5 ha) are located on the area of S = 102.0 ha. In addition to Blocks 2 and 3, there are pioneering sludge fields (area S = 12.35 ha) and reserve area. Area of S = 102.0 ha is located to the west of the village Bortnychi. From the west side the BAS borders with the bank area of lake Tyagle, from the north - Kollektorna Street. From the east side it borders with the main channel, from the south - natural boundary Berezivka. The relief is plain, vertical drop marks - 0.9m.

The P/S "Pozniaky" is situated on the territory of S = 1.2 ha, bounded from the south side with Kollektorna Street. The P/S "Right Bank" is located on2/5, Promyslova Street; the area of the territory is S = 1.05 ha. The pumping station "Bortnychi-Vyshenky" is located to the east of the village Gnidyn. The pumping station of industrial water is located on 5 ha on Promyslova Street. The fuel economy – 11 is on the Avtoparkova Street; a total area of the territories - S = 9.5 ha.

Sludge fields of the total area 272 ha, located in Boryspil district of Kyiv region, consist of sludge fields of № 1, № 2, № 3 (additional) and pioneering sludge fields.

Sludge fields No. 1 of the area 54.95 ha consist of two parts: first, with the area of 27.4 ha (natural subsoil) and second with the area of 27.5 ha (asphalt base) and are located to the northwest of the village Gnidyn, bounded from the south by Bugayova valley.

Sludge field No. 2 with total area of 65.0 ha, is located to the northwest from the village of Revne, from the north it is bounded by the area adjacent to the road going to the village of Matusivka.

Sludge field No. 3 (additional) with the area S = 80.85 ha is adjacent from the north side to the sludge field No. 2.

Pioneer sludge field with a total area of 12.35 ha (with asphalt base) are located on the territory of the second block of BAS.

The main channel, which part with the area of S = 5.9 ha, is located within Kyiv, and the other with the area of S = 1.7 ha in Boryspil district of Kyiv region.

Enterprise borders with:

From the north - Kollektorna Street, Lake Vyrlytsia, residential area "Kharkivsky", "Kyivenergo" plant "Energy", GP "AvtoMaz-Ukraine", LLC "Contactor ", LLC "Porsche Ukraine", production base of JSC "Fundament", CJSC "Vtorresursy No. 3 ", JSC "KML "Tekstemp", VSAU "Parking № 6", LLC "Yaroslav-car", SATP "Ukrlift", LLC "SHBU-27 "Kyyivshlyahbud-1", VN0 "Temp", JSC "Trant", plant "Radiovymiryuvach", LLC "Autobaza № 1", SRBU "Kyyivlift-2", JSC "Engineering", LLC "Austral", branch cable network "Kyivenergo", GP NDKT Institute of Urban Development, SS №1 "BRPS" "Kyivenergo".

From the east - Avtoparkova Street, residential construction of village Bortnychi, Academy of Internal Affairs of Ukraine, JSC "AIT", JSC "Kyyivmedrembud", KBMU "Ukrmontazhlehmash", OJSC "Company" Fundament", UCB OJSC "AK" Kievvodokanal', technical department of OJSC "AK"Kievvodokanal", Ltd. "Promhim technology", "Company" Ukrgidrospetsbuild ", OJSC "Trest KyivPidzemShlyakhBud-2", JSC "Scientific and restoration PBV JSC "Ukraine-restoration", DKRBU No. 2, STOV "Trebuhivske", PS "Lugova" AJC "Kyivenergo".

From the south - residential construction of Bortnychi village, wasteland, urban land, not provided for the ownership or use, DP "Kyyivenerhopidryad" AT "Kyyivenerhobud".

From the west - natural boundary Berezivka, lake Tyagle and Nebrezh, urban land, not provided for the ownership or use, private enterprise "Alternative", LLC "Frost-Alpha. "

Residential area is located:

From the north - residential construction area on Revutsky Street, Vishnyakovska Street and Bazhana avenue at the distance of 1000 - 1375 m;

From the northeast - a house on the 3 Kollektorna Street, at the distance of 325 m, residential construction on6 Svitla Street, Bortnychi village at a distance of 700 m from the boundaries of the enterprise.

From the east - residential construction exists at (individual housing construction)Luhova Street, Chervonoarmiyska Street, Kotsyubynskogo Street, Karl Marx Street, Kotovskogo Street, Chelyuskintsiv Street, Kalinina Street, Engels Street of Bortnychi village at the distance of 300-400 m from the boundaries of the enterprise, residential construction on the Lenin Street at the distance of 950-1050 m from the boundaries of the enterprise,

From the southeast - residential construction (individual housing construction) on the Berezneva Street, Levadna Street of Bortnychi village at the distance of 900-1100 m from the boundaries of the enterprise.

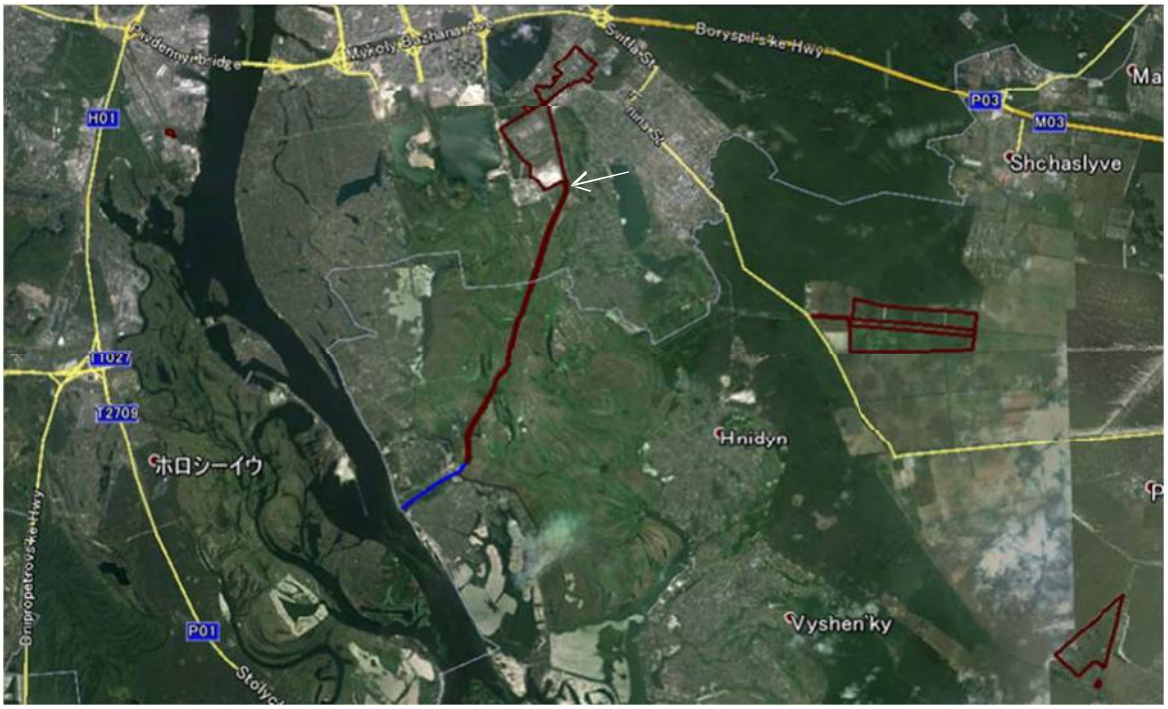
The relief is plain and the surface is an altitude of 171.8-173.9. Within the land, on which the design is done, objects of natural reserve fund are not present. The area is free from construction.

Situation map-area of the layout of design is shown in Figure 4-1.

Figure 4-1 Satellite Photo of BAS

The area of BAS is 140.3 ha, sludge field No. 1 is 54.95 ha, No2 is 65.0 ha, and No.3 is 80.85 ha. The part of channel with the area of 5.9 ha is located in Kiev city and the other part with the area of 1.7 ha is in Boryspil district of Kiev Region. The discharge point is about seven km from the BAS through the channel, which is used only for effluent discharge.

No.2



Source: JICA Study Team

Figure 4-2 Location of BAS and Related Facilities

4.2. Geology

In terms of geomorphology, the Project area is located within the left-bank floodplain terraces of Dnipro, raised by adding and alluvium of soils to the absolute marks of the surface of 97.0-98.5m. The treatment facilities are located in the northwest to the village of Bortnychi and is the south-eastern part of Kyiv.

From the surface alluvial deposits are covered with the layer of bulk and drift soil. Bulk soil is composed of sand and clay sand gray, brown-gray, mixed. Drift soil is composed of sand yellow, light yellow, containing plant residues.

In the thickness of alluvial sands there are clay sands and cay loams, containing organic matter.

Alluvial deposits are located in soils of Buchaksky Paleogene, represented by sand, clay sand and loam sand greenish-gray.

Geotechnical studies on the design area were completed by LLC "Medinzhservis" in 2013.

As the result of static probing, thickness of the alluvial sand genesis is located mainly in dense state, occasionally medium density.

On the basis of geotechnical studies, including lithology and physical condition of the soil, in the total thickness of Sludge identified were 14 geotechnical elements, geological and lithological characteristics of which are set out below:

- IGE 1 - bulk soil - sand, clay sand, clay loam mixed, dark gray, dark brown, containing construction residues of up to 40% and containing organic mixtures.
- IGE 2.2 -adrift soil - sand yellow, light yellow, small and medium size, occasionally with layers of clay sand: loose 2n-2 - medium-density and dense. It should be noted that according to static probing there was revealed soil in loose condition (loosening of sand), mainly observed near the sedimentation tanks.
- IGE 3 Plant soil - sand, clay sand, clay loam dark gray, humus, sometimes peaty.
- IGE 4/4s Sand gray, light gray, small, occasionally medium size, 4 - dense, 4 c - medium density.
- IGE 5 Sand dark - gray, black, small, mixed with organic matter, loose.
- IGE 6 - Clay sand gray, brown-gray, sometimes with layers of sand.
- IGE 7 Clay sand dark gray, with mixtures of organic matter.
- IGE 8 Clay loam gray, light gray, with layers of sand.
- IGE 9 Clay loam dark gray, with mixtures of organic matter.
- EGE 10 Clay loam dark gray, black, peaty.
- IGE 11 Peaty dark brown, black.
- EGE 12 Clay loam of Kyiv paleogene, blue-gray, light gray, carbonate.

During study within the areas of hazardous geotechnical processes there was identified flooding "bleak", and among the negative factors should be considered presence of loose soil (loosening condition), soils with poorly durable features - layers EGE-7, 9, 10 and aggressiveness of groundwater containing aggressive carbon dioxide (CO2).

Groundwater was recorded during the drilling process at depths of 2.7 - 4.1m, within the absolute marks 92.96-93.65m. their refilling is due to infiltration of precipitation, buchaksky aquifer and losses water communications.

4.3. Hydrology

Most of Ukraine has a moderately continental climate, 2/3 of the territory is under conditions of unfavorable water regime and it gave rise to the development of reclamation on this territory. The major river, fed by numerous tributaries, is the Dnipro River which bisects the country as well as Kiev into two party - right-bank and left-bank parts. The rivers of Southern and Steppe zones are often dried up in summer. Thawed snow plays the main role in the feeding of plaint rivers (50-80%). The reserves of water resources are about 95 billion cubic meters, including 3.2 billion of cubic meters of underground water. The hydrological regime of the River Dnipro is shown in Table 4-1. The river flow peaks in May and bottoms in November. Yearly fluctuations are as large as five to thirteen times between minimum and maximum flows. Given the daily outflow from the BAS of around one million m^3, the share of the effluent to the river is 3% at a historical maximum.

Table 4-1 Dnipro River Hydrological Features

No	month	Year of minimum discharge	Year of maximum discharge	Q month min [m^3/s]	Q month max [m^3/s]	Q month mean [m^3/s]
	January	1952	1975	435	2660	1369
2	February	1954	1975	439	2770	1602
3	March	1954	1970	456	3040	1673
4	April	1984	1970	483	6210	2478
5	Mai	1961	1958	686	8040	2893
6	June	1965	1958	668	3310	1617
7	July	1960	1974	507	1910	1058
8	August	1959	1980	409	2000	942
9	September	1954	1980	457	1850	841
10	October	1959	1980	487	1840	980

11	November	1983	1980	362	2470	1111
12	December	1953	1980	365	2440	1241

Source: Vörösmarty, Charles J (2003): Dniepr river, Hydroelectric Plant, monthly discharge, years of min and max. doi:10.1594/PANGAEA.103741

A rise in groundwater levels is possible up to 1.2m from the recorded. the area is potentially flooded. Type of the area for potential under flooding - Type3. During the flood on Dnipro of 1%, rising of groundwater can achieve abs. mark of 96.2m considering the construction area at a distance of 330m from the boundary, and buking territory to the abs. marks of 97.0-98.5m.

Seasonal freezing of soil is up to 1.1m. The closest water body to the area is Dnipro.

4.4. Flora and Fauna

Wildlife of Kyiv region is very diverse. the richness of species composition due to the fact that the region is located between two natural areas: northern part is located in Polesia, south of the region is in the forest-steppe zone. Habitats of Kyiv are represented with natural habitats (forests, grasslands, wetlands, floodplains, ponds) and habitats radically altered by humans (farmland and settlements). The following kinds of fauna are characteristic for areas of agricultural land distribution: mammals (normal hamster, mouse wild), birds (grouse, lark, field sparrow, crow, kite black).

The following representatives of the wild life are distinctive for habitats of settlements: mammals (bats, mice, black rats), birds (white stork, pigeon, robin, blackbird, finch, owl, dove gray, sparrows, magpies). Area of the proposed activity in mammalian species composition refers to the area of Pravoberezhny (Right-Bank) forest-steppe (North East Dnieper, Kyiv, Central and Pivdennoprydniprovska (South-Dnipro) highland region). This area can contain mammal species listed in Annex II of the Bern Convention, namely the steppe polecat (Mustela eversmanni), river otter (Lutra lutra), gopher marbled (Spemophillus suslicus), forest mouse (Sicista betulina) and commonhamster (Cricetus cricetus).

The lands including the project area contain marked territories of distribution of mammals listed in the Red Book of Ukraine (1995), including: small water shrew (Neomys anomalus), small horseshoe (Rhinolophus hipposidores), Bechstein's bat (Myotis bechsteini), pond bat (Myotis dasycneme), tricolor bat (Myotis emarginatus), shovkovuh European (Barbastella barbastella), small noctule (Nyctalus leisleri), nig noctule (Nyctalus lasiopterus), Mediterranean bat (Pipistrellus kuhll), garden dormouse (Ellomys quercsnus), blind mole rat

(Nannospalax leucodon), mole rats Podolsky (Spelax graecus), ermine (Mustela ermmela), steppe polecat (Mustela eversmanni), badger (Meles meles), river otter (Lutra lutra).

Area of the design activity relates to the areas (according to the zoning in species composition of birds in 2000) where the total number of bird species listed in the Red Book of Ukraine, makes from 10 to 20 species, the highest proportion of species composition of birds in the area is occupied by number of birds of prey (Falconiformes), shore birds (Charadriiformes). On the territory of the projected area number of species genus of lepidopteras (Lepidoptera), listed in the Red Book of Ukraine makes more than 20 units. As for the seasonal migration of birds, the area of the proposed activity relates to the northern part of Ukraine, which is marked by the passage of the Polisky migration routes of birds: in spring migration direction moving east, in autumn - west. Also, the area refers to Dnipro migratory path of birds that covers the territory lying close to Dnipro; in spring migration are moving downstream of Dnipro; in autumn - upstream.

Total area of forest fund of Kyiv region is about 746,000 ha. For the northern part of the region typical are tracts of coniferous and mixed forests, the southern part is largely cultivated on those areas that are not subjected to strong anthropogenic influence, dominated by deciduous forests. Main types of vegetation, that prevail in the area, are pine and oak-pine forests, meadows and farmland in place of forests, meadows and marshes. The number of alien plant species in areas of the route is from 550 to 600.

4.5. Climatic Conditions

Climatic conditions of the territory are one of the key factors that determine its operation. the climate is temperate with moderately cold winters and hot summers. The average annual rainfall is 685mm. Summer rainfall is in the form of brief heavy rains. Most water quickly runs down the hydrographic network. Snow cover lays from December 22 to March 14. Snow depth varies from 10cm in December to 74cm in February. Freezing depth of soil is 1.1m. Relative annual humidity is at minimum during May-September, maximum - December - January. Steady shift of average daily temperature at 0°C is at the end of March and the end of November. Average temperature of the coldest month of January is -5.9C, the warmest month of July is +19.8. Absolute maximum temperatures fluctuates between +39°C, minimum - 39°C. Average annual wind speed is 2.7 m/s. The greatest number of days with strong winds are in February and March (4.3 m/s), the lowest - in August. In winter prevail westerly winds, in summer – northern winds.

In general, the climatic conditions of the territory studied can be characterized as relatively acceptable.

The natural and climatic conditions, according to p. 1.2 DSTU-N B V.1.1-27:2010 are accepted for the construction area – city of Kyiv for the year of 2010.

According to the DSTU-N B V.1.1-27:2010, the territory belongs to the northwest climate area (Polessia, forest steppe), which has the following climatic indicators and characteristics:

Table 4-2 Climatic Summary of Kiev Region

Climatic area, subarea	Air temperature, °C				Annual precipitation, mm	Relative humidity in July, %	Aver. Wind speed in Jan, m/s
	Average in		Abs. minimum	Abs. maximum			
	January	July					
I - Northwest (Polissya, forest steppe)	from -5 to	from 18 to	from -37 to -40	from 37 to 40	from 550 to 700	from 65 to 75	from 3 to 4

Number of heating-degree days is 3500 (image 2).

Table 4-3 Monthly air temperature, (° C)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
-4,7	-3,6	1,0	9,0	15,2	18,3	19,8	19,0	13,9	8,1	1,9	-2,5	8,0

The average annual air temperature equals to +8,0 ° C. The warmest month is July with average temperature +19,8 °C. The coldest month is January with average temperature -4,7 ° C. Estimated temperature of the coldest 5 days : – 22 ° C. Heating period is 176 days, average temperature during the heating period equals to: – 0,1 °C.

Table 4-4 Average precipitation (mm) and Snow Cover(days)

Average monthly precipitation, mm, Presence of snow cover, days												Total precipitation level, mm
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
41	42	40	48	56	76	77	68	55	42	51	46	642
26	25	17								7	20	

Average annual precipitation is 642 mm. In average there is 114 days with precipitation in the city, the least is in July and September (6 days/month), the most – in December and January (14 days/month). Snow cover duration in days: November – 7, December – 20, January – 26, February –25, March –17. Average relative air humidity in Kyiv is 74%, lowest (62%) is in May, highest(85%) – in December.

Table 4-5 Relative Air Humidity, (%)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
83	79	74	66	62	68	69	68	74	77	84	85	74

Prevailing wind direction, its repeatability % per month/average wind speed,(m/s) are determined according to Table 4-6.

Table 4-6 Prevailing Wind Directions

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3,24/ 2,8	South-East,18/ 2,9	South-East, 17/2,7	North, 16 /2,6	North, 17/ 2,3	North,19 2,2	3,2/2,1	North, 21/2,0	3,24/ 2,1	3,21/ 2,3	3,21/ 2,6	3,21/ 2,7

Western winds have the highest repeatability, - winds from North-East and East – lowest repeatability. Wind speed is not high in the city. It is the highest in February for winds of south-eastern direction, the lowest – in August for winds from North.

Table 4-7 Climatic-meteorological Indicators:

Name of parameter	Quantity		
Parameter, that depends on the stratification of the atmosphere, A	180		
Terrain relief coefficient	1		
Average ambient temperature of the hottest month, T°C	+25.4		
Average ambient temperature of the coldest month (for boiler houses, working on heating schedule), T°C	-4.7		
Wind diagram, %	January	July	Average annual
North	11.2	18	*13.6*
North-East	4.6	9.1	*9.1*
East	5.8	4.8	*8.8*
South-East	11.9	8.0	*12.8*
South	14.1	11.3	*13*
South-West	14.0	10.4	*11.5*
West	23.5	20.4	*17.7*
North-West	14.9	18.0	*13.5*
Lull(no wind)	4.2	9.2	*13.0*

Wind speed (average long-term data), excess of repetiion of which is 5% - 7 m/sec.

Snow load according to the requirement of the attachment E DBN B.1.2-2:2006 «Load and impacts»-1550 Pa (155 kgf-m). Wind pressure speed on 10 m height above ground level – according to attachment E DBN B.1.2-2:2006 - 370 Pa (37 kgf-m). The climatic conditions of the constuction site conform to the ones in the city.

4.6. Society and Economy

The BAS receives sewage from nearly 100% of the residents of the city of Kiev. Table 4-8 shows the transition of population in Kiev City.

Table 4-8 Transition of Population in Kiev Region (Except Kiev City)

Unit: People

Year	Living Population			Permanent Population		
	Total	Breakdown		Total	Breakdown	
		Urban	Rural		Male	Female
1999	1,875,600	1,065,900	809,700	1,868,400	863,200	1,005,200
2000	1,861,500	1,058,700	802,800	1,851,900	856,000	995,900
2001	1,843,400	1,059,700	783,700	1,835,100	848,200	986,900
2002	1,827,900	1,053,500	774,400	1,821,100	841,500	979,600
2003	1,808,300	1,049,400	758,900	1,802,600	833,000	969,600
2004	1,793,900	1,051,500	742,400	1,788,100	826,000	962,100
2005	1,778,900	1,050,100	728,800	1,773,100	818,700	954,500
2006	1,763,800	1,049,700	714,100	1,758,000	811,100	946,900
2007	1,751,100	1,050,400	700,700	1,745,300	804,700	940,600
2008	1,737,300	1,048,800	688,500	1,731,500	797,800	933,700
2009	1,727,900	1,049,800	678,100	1,722,100	793,400	928,700
2010	1,721,800	1,052,100	669,700	1,716,000	790,800	925,200
2011	1,717,700	1,053,600	664,100	1,711,900	789,700	922,200
2012	1,719,500	1,059,100	660,500	1,713,800	791,400	922,400
2013	1,722,000	1,064,800	657,200	1,716,300	793,300	923,000

Source: Department of Statistics, Kiev Region

The immediate vicinities of BAS are allocated to mostly commercial activities. The areas beyond the Sanitary Protection Zone are predominantly residential with local commercial activities. There are estimated 20 million population who depend on the Dnipro Rive downstream of the discharge point of the effluent from the BAS.

BAS is located on the South-Eastern boundary of Darnytsia District of Kyiv, as shown on the map below in Figure 4-3. The distance from BAS (№ 1on figure above) to residential development is: of Bortnychi residential area (№2) - about 500m to the production facilities; from residential areas along Bazhana avenue (№3) - about 1.4 km; from residential development along Revutskoho street (№4) - approximately 1.07 km.

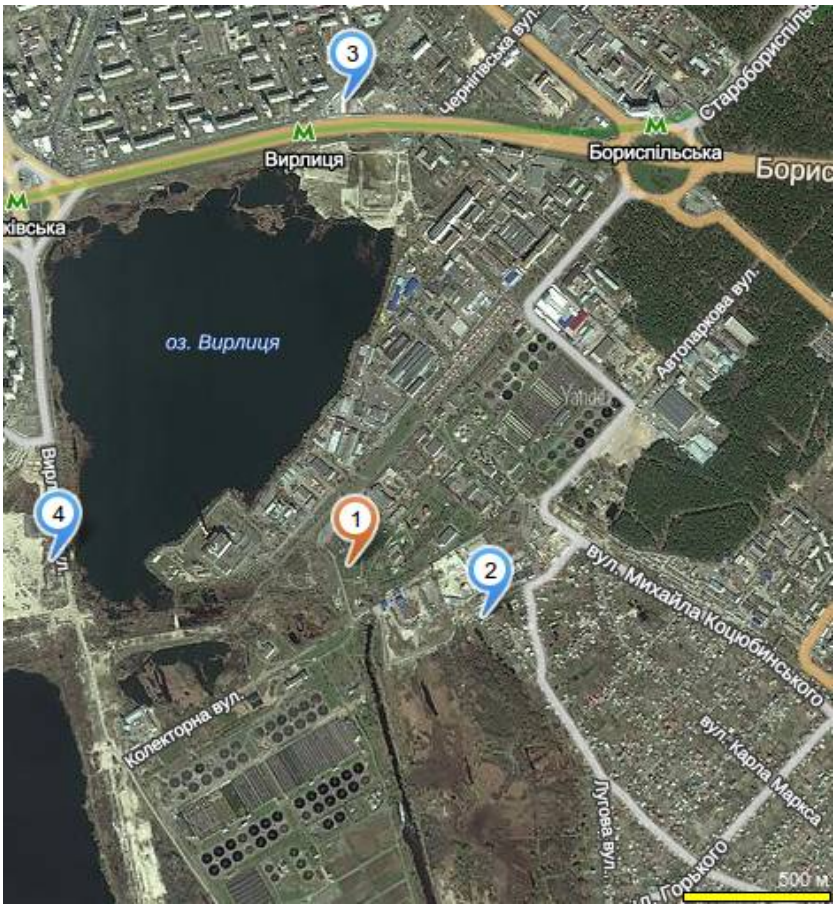


Figure 4-3 BAS and Neighboring Residential Areas

In the years 2013-2104, JICA Study Team[2] has collected and analyzed information regarding the complaints of local residents to Kyiv City State Administration about odor coming from sewage treatment facilities of BAS (point № 19) as shown in Figure 4-4. The addresses of these complaints have been plotted on the city map (see above), resulting in a visible trend of spreading of odor 4-5 km into the residential areas of Osokorky, Pozniaky, Kharkiv and Bortnychi. Thus, we may assume that the odor spreads throughout the entire area of Darnytsia district.

According to the Statistical Yearbook of Kyiv for 2013[3] , the total population of Darnytsky District on January 1, 2014 amounted to 324,988 people, or 11.33% of the existing population of Kyiv.

[2] Report of the JICA Study Team Report on the Project for Reconstruction Bortnychi WWTP, March 2014.

[3] State Statistics Service of Ukraine. Department of Statistics in the city of Kyiv. Statistical Yearbook of the city of Kyiv for 2013. K. "Consultant Publishing", 2014. – 447 p. Page 214.

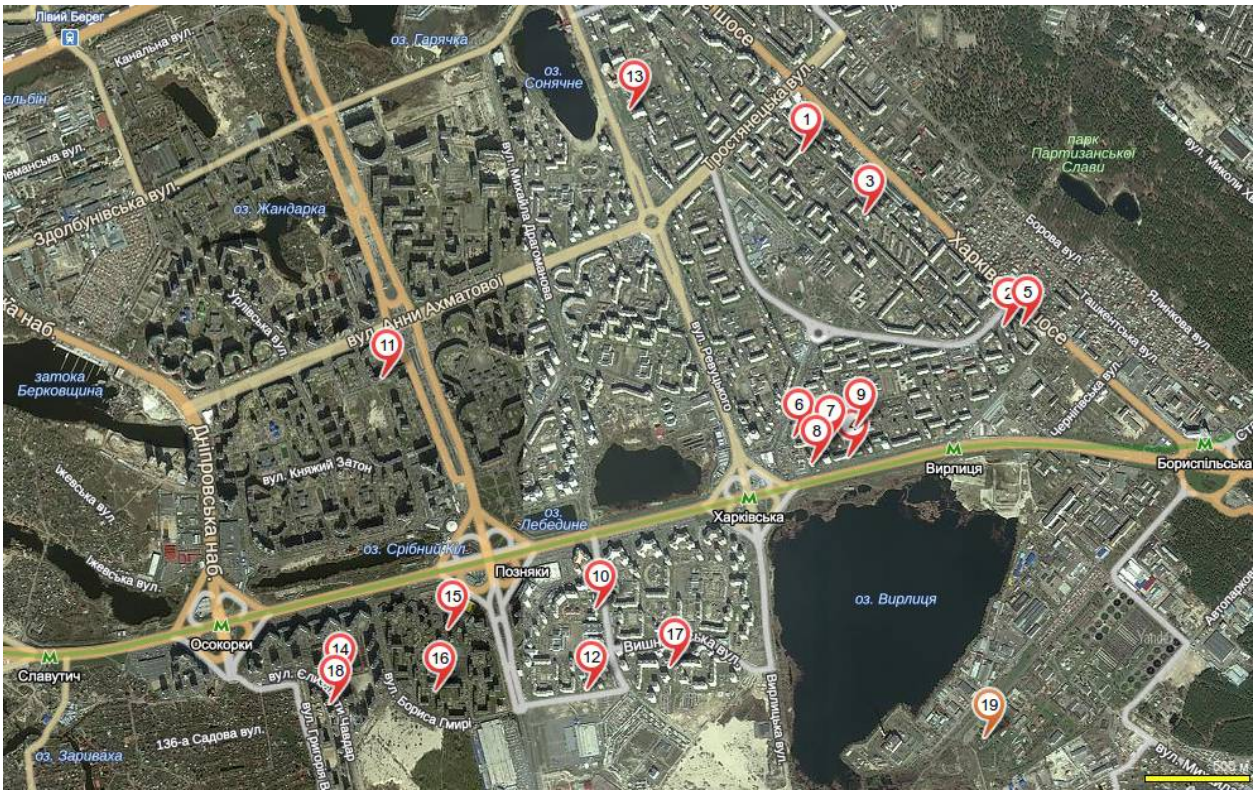


Figure 4-4 BAS and Neighboring Residential Areas

5. ANALYSIS OF ALTERNATIVES

Although the proposed plan may offer a solution for the identified problems faced by the BAS operations, it is necessary to make certain that it is the optimal solution of all the conceivable options.

5.1. Alternatives for sludge treatment and disposal

There are alternatives for sludge treatment and disposal:

- Treatment and disposal at the sludge field (drying bed) - alternative 0 (Without Project)
- Dewatered and disposed at the solid waste treatment site - alternative 1
- Dewatered and incinerated solid waste in the incinerator - alternative 2
- Dewatered and incinerated sludge at the new incinerator within the BAS - alternative 3

Alternative 0: Treatment and disposal at the sludge field (drying bed)

Sludge is transferred to the sludge fields outside of the BAS by pumps, dried by the sun and stored in the sludge field. As described in the 3.1.2, the current process of sludge disposal only increases the sludge volume vertically with high content of water. The only solution for the current method is to acquire a large tract of sludge field to let the natural process to vaporize the water content of sludge completely. The available information on evapotranspiration and precipitation indicates that in Kiev region has estimated precipitation of 500 mm per year and evapotranspiration of 800mm per year. Thus 300 mm is the maximum evaporation potential in an open field, indicating the annual sludge volume needs to be spread over the area with a depth of no more than 30 cm. Given the estimated daily volume of 6,000 m3 to 12,000 m3, the corresponding required areas are 800 ha to 1600 ha. The current area of sludge field needs to be expanded by three to six times. However, this option will necessitates a large scale of land acquisition, loss of agricultural production and continued environmental nuisance to the surrounding areas of the sludge fields. The sludge fields need to be expanded permanently with this option.

Previously, KVK made the request to allocate the additional area for sludge field to Kiev City but the request was rejected. This alternative is not possible as there is no allocation of additional area for sludge field.

Alternative 1: Dewatered sludge and disposed at the Solid Waste Landfill

The solid waste landfill site is located in Pidgirtsi, Obukhov district, Kyiv region, about 30 km away from Kyiv. Operation was started in August 1986 and 50% of solid waste generated in the city is disposed in this landfill site. Its total area is 63.7 ha. Due to the environmental problems, the landfill site should be closed by 2018 and after that the untreated waste cannot be disposed of at the landfill. Waste should be incinerated or recycled instead of being sent to the landfill. Sludge contains heavy metals and transportation of the dried sludge is prohibited since 1985. Transportation and disposal of sludge to the sludge field is not possible.

Alternative 2: Dewatered and incinerated at the existing incinerator sludge

There is an incinerator plant for solid waste in Kiev, which started operation in 1988. Waste incineration plant "Energiya" has four furnaces, three in operation and one for back up. The capacity of the incinerator is about 250 thousand ton/year. The facility has outdated equipment and needs renovation. The WWTP generates around 78 thousand ton of sludge per year, equivalent to more than 30% of the capacity of the incinerator. To treat the sludge, additional incineration capacity will be required. Thus, this option is not any different from the proposed Alternative 4.

Alternative 3: Dewatered and incinerated sludge in the new incinerator in the BAS

Sludge will be dewatered and incinerated at the new sludge incinerator which is constructed within the BAS. The land is not required as the area within the BAS can be used for the construction of incinerator. The sludge volume can be reduced to one tenth after the incineration and it eliminates the necessary area for sludge field. The incinerated ash can be used as the ingredient of cement, asphalt mixture and concrete products. There will be increased emissions of nitrogen dioxides and carbon dioxides. However, electric filters will remove 99% of heavy metal compounds and scrubbers will reduce sulfur oxides. Under the current operations, there are significant emissions of methane, hydrogen sulfides, and ammonia to causing serious air pollution together with odor problems in the vicinity of the BAS. This alternative will nearly eliminate these emissions. The emitted flue gas will meet the standards. Among the four alternatives, this option is the most environmentally accepted to be implemented.

6. Proposed Plan and EIA Scoping

6.1. Current Facilities and Operation

6.1.1. General Situation

The existing facilities were designed and constructed in the 50's and 60's of the last century, and at present are not only worn out physically, but also outdated technologically. In the BAS, there are three sewage treatment lines named as Block 1 to 3.

The facilities of Block 1 of the station are in the most critical condition. They are set for operation since 1964. Sewage treatment facilities have exceeded their exploitation term and are in need for immediate reconstruction. The priority issue is construction of new pumping station of the 1st rise, which sends waste water to Block 1 of Bortnychi WWTP, suffers from low operation efficiency of existing screening department. According to the project, 16 mm screens are installed in the screening department of Bortnychi WWTP. The screens, due to large size of the holes, are not sufficient to keep all the waste, which is forwarded to the station along with sewage, resulting in forwarding waste to the facilities of mechanical treatment of sewage - sand catchers and primary sedimentation tanks. Thus, clogging of the facilities occurs, leading to disturbances of operation. The waste, accumulated in the primary sedimentation tanks, is pumped to the digesters along with raw sludge. During the pumping process, occurs clogging of pumps pumping sulfuric sludge, which leads to their breakdown. Accumulation of raw sludge in the sedimentation tanks of digestion tanks, especially in summer, results in the release into the atmosphere of methane and hydrogen sulfide.

6.1.2. Sludge Disposal

In 1985, by the decision of Boryspil sanitary-epidemiological station, the removal of sludge from sludge fields was banned due to high content of heavy metals, making it impossible to use the m in agriculture as organic and mineral fertilizers. Thus, for the past 20 years, export of sludge from the sludge fields almost did not take place. Due to such situation, sludge fields were turned into sludge accumulating areas. the actual volume of sludge, located in the fields in more than 3 times exceeds the projected one (as of 2012 actual volume of sludge is more than 10 million m^3, with design volume - 3 million m^3). there are no reserved areas on the sludge fields.

Taking sludge to the sludge fields during the last decade was possible only by means of growing dams between the fields. However, further application of this method is no longer

possible - the height of the dams has already reached critical values. This led to their leakage in some areas and the outpouring of sludge into the surrounding areas.

Due to the critical situation today, it is possible to grow some more dams on sludge fields No. 1 and No. 2, which will, at least for sometime, prevent leakage of sludge into the surrounding area and to ensure the removal of sludge from the technological facilities of the station. Growing dams will not solve the problem of sludge processing, but only allow taking sludge to the sludge fields for maximum of 1-1.5 years.

Today the overflow of sludge fields with sludge has led to various negative consequences. Dramatically increased concentrations of pollutants in the supernatant water are sent for treatment to the facilities of Block 2 of the station. As the result, there has been an increase in concentrations of pollutants in the wastewater, forwarded for treatment, which cause increasing pressure on the facilities of mechanical and biological treatment, increasing volume of raw sludge and excess active sludge, increase of power consumption. Secondly, the overflow of sludge fields has led to inability of timely removal of the excess sludge from the facilities. As the result - accumulation of raw sludge in primary sedimentation tanks, increase of sludge dose in aeration tanks and depreciation of quality of wastewater treatment.

In addition, it should be noted that this method of sludge processing (dewatering in the sludge fields) is practically not used in any European country. Further use of existing sludge fields will lead, ultimately, to their overflow, breaking of dams, outpouring of sludge to the agricultural fields and adjacent areas. And in few years, when sludge fields will be completely overflown - to the inability of sludge removal from the station facilities, treatment of wastewater of Kyiv and discharge of untreated sewage in the river Dnipro.

6.2. Design Solutions

There are two main activities of the Project; 1) introduction of incineration process of sewage sludge and 2) reconstruction of the sewage treatment facilities.

The designed total flow of wastewater that enters BAS facilities amounts to 1,573,000m3 per day (in accordance with the "Scheme of water supply and sanitation of Kyiv for the period up to 2020" approved by Kyiv City decision of 12.07.2007 No. 1173/1834).

The purification line is developed based on the following initial data:

- maximum daily water consumption (nominal) – 1,573,000 m3/day;
- average daily water consumption – 1,123,600 m3/day;
- maximum hourly water consumption –81,8000 m3/hr.

The design and construction of Bortnychi WWTP facilities is provided in 2 lines with highlighting five Components.

The project is composed of :

- reconstruction of the main sewage pumping stations (SPS) "Pozniaky", "Right Bank" that ensure a reliable supply of wastewater to treatment facilities using the latest equipment and systems of air deodorization;
- construction of new Blocks1, 2, and reconstruction of the existing Block 3 of treatment facilities of mechanical and biological treatment with the introduction of modern energy efficient equipment;
- reconstruction of major structures such as pipelines, collectors, canals, which are integral part of the complex of treatment facilities;
- construction of axillary buildings and facilities to serve the primary technological process.

These and other measures aims at improving technological process of wastewater treatment to the levels of standard indicators, that comply with the established restriction on the content of pollutants in treated wastewater, discharged into the river Dnipro, which is the main source of water supply in Ukraine.

Estimated maximum daily flow of wastewater of treatment facilities of Bortnychi WWTP (BAS) is 1,573,000 m^3/day, of which:

-for Block 1 – 577,000m^3/day – 30000m3/hr;

-for Block 2 - 577,000 m^3/day – 30000m3/hr;

-for Block 3 - 419,000 m^3/day –21800 m3/hr.

BAS treatment facilities have been designed using the following technological scheme:

- primary treatment of wastewater in the reconstructed sewage pumping stations;
- preliminary mechanical treatment:
- two levels of fine mechanical treatment (screens);
- removal of sand and floating substances (sand and fat catchers);
- primary sedimentation tanks of lamella type;
- biological treatment;
- secondary sedimentation tanks;
- system of advanced treatment;
- ultraviolet disinfection;
- treatment and disposal of sludge.

According to the design, full reconstruction of treatment facilities, technical infrastructure, landscaping, treatment technology and sludge disposal are provided, and are carried out in the following sequence:

1st stage:

Component 1 ("Technical re-equipment of facilities of Blocks 2and 3 to ensure regulatory treatment of the entire volume of wastewater during construction of the new Block 1 with installing air deodorization system from block facilities"):

- construction of complexes of mechanical treatment for Blocks 2 and 3 of treatment facilities, including:
  - screening department of medium and fine treatment;
  - sand and fat catchers;
  - primary sedimentation tanks;
  - air deodorizing system,
- reconstruction of the existing secondary sedimentation tanks of Block 2 (№ 17-28) and Block 3 (№ 30, 31, 33, 34, 36, 41, 42);
- reconstruction of the existing sludge thickeners of Block 2 (№ 5-7);
- replacement of existing 8 units of air blower stations on Blocks 2 and 3 (4 units at each station);
- replacement of aeration systems in the existing aeration tanks № 7-12 of Block 2;
- reconstruction of aeration tanks № 13-14 with arranging nitrification-denitrification zones and biological removal of phosphorus;
- construction of main and backup areas of sand storage;

Component 2 - construction of mechanical dewatering of sewage sludge department with transport and sludge accumulation facilities.

- construction of gravitational thickeners of raw sludge from the primary sedimentation tanks;
- construction of complex of thickening the active sludge with reservoirs of thickened and digested sludge;
- construction of section of mechanical dewatering of sludge;
- construction of sites for storage of dewatered sludge for further thermal utilization;
- construction of industrial and domestic facility of the section of sludge treatment;
- construction of service and domestic facility of BAS;
- construction of chemical and bacteriological laboratory

Component 3 - construction of new technological line of disposing sewage sludge with the plant of thermal sludge disposal.

−construction of incineration facilities for dewatered sludge and steam turbine

- construction of warehouse storage of ashes;
- construction of additional production and household maintenance units of BAS.

Component 4 - construction of new Block 1 with installing systems of air deodorization from facilities.

- construction of mechanical treatment unit, including:
  - screening department of medium and fine treatment;
  - sand and fat catchers;
  - primary sedimentation tanks;
- air deodorizing system;
- construction of biological treatment line, including;
- aeration tanks;
- air blowing stations;
- secondary sedimentation tanks;
- distribution chambers;
- pumping stations of return and excess activate sludge;
- construction of complex of advanced treatment and disinfection of wastewater;
- construction of receiver structure and composition for wet storage and dispensing;
- construction for output into the main channel No. 1;
- construction of industrial and domestic section of block of treatment facilities No. 1;
- construction of water supply pumping stations;
- construction of Automatic control of physical and chemical parameters of treated wastewater in the waste feed of BAS.

Component 5 - reconstruction of the main channel of treated wastewater and dispersing discharge.

- dismantling of existing buildings and structures.
- hydraulic fill of the territory;
- installation of technological line for emptying "Pioneer" sludge fields to enable the construction development of the area.

2nd stage

Component 6 - reconstruction of sewage pumping station "Pozniaky" with arrangement of air deodorizing system.

- Reconstruction of SPS "Pozniaky" with replacement of main technological equipment and installation of air deodorizing system.

Component 7 - reconstruction of "Right Bank" sewage pumping station with the installation of air deodorizing systems.

- Reconstruction of "Right Bank" SPS with the replacement of the main technological equipment and installation of air deodorizing system.

Component 8 - construction of new Block 2 of the station.

- construction of biological treatment line, including:
- aeration tanks;
- air blowing stations;
- secondary sedimentation tanks;
- distribution chambers;
- pumping stations of return and excess active sludge;
- construction of complex of advanced treatment and disinfection of wastewater;
- construction of wet storage warehouse and dispensing of reagents for Blocks 2 and 3;
- construction of output into the main channel No. 2;
- construction of industrial and domestic section of treatment facilities Block 2;
- dismantling of existing buildings and structures.

Component 9 - reconstruction of facilities of Block 3 of the station.

- construction of additional facilities for biological treatment line, comprising:
- secondary sedimentation tanks;
- distribution chambers;
- pumping stations of return and excess active sludge;
- construction of complex of advanced treatment and disinfection of wastewater;
- construction for output into the main channel No. 3;
- construction of industrial and domestic building of block of treatment facilities No. 3;
- replacement of the existing aeration systems in the aeration tanks № 17-18 of Block 3;
- replacement of existing 4 air blowing units at the air blowing station of Block 3;
- reconstruction of existing pumping stations of aeration tanks No. 5, 6;
- reconstruction of existing secondary sedimentation tanks of Block 3 (№ 29-42).

Component 10 - construction of motor transport service and repair units.

- construction of additional buildings, including:
- industrial building for motor transport;
- maintenance building for motor transport;

- section of repair of mechanical and pumping equipment;
- section of repair of electrical equipment No. 4 (REU № 4);
- maintenance building RMNO REU No. 4;
- construction of pumping stations for pumping sludge from sludge fields № 1, № 2 and № 3 on the line for processing and disposal of sludge;
- reconstruction of main channel of treated wastewater and scattering issues.
- installing process line for emptying sludge fields;
- dismantling of existing buildings and structures.

The flow chart of the technological process of proposed treatment facilities is listed below.

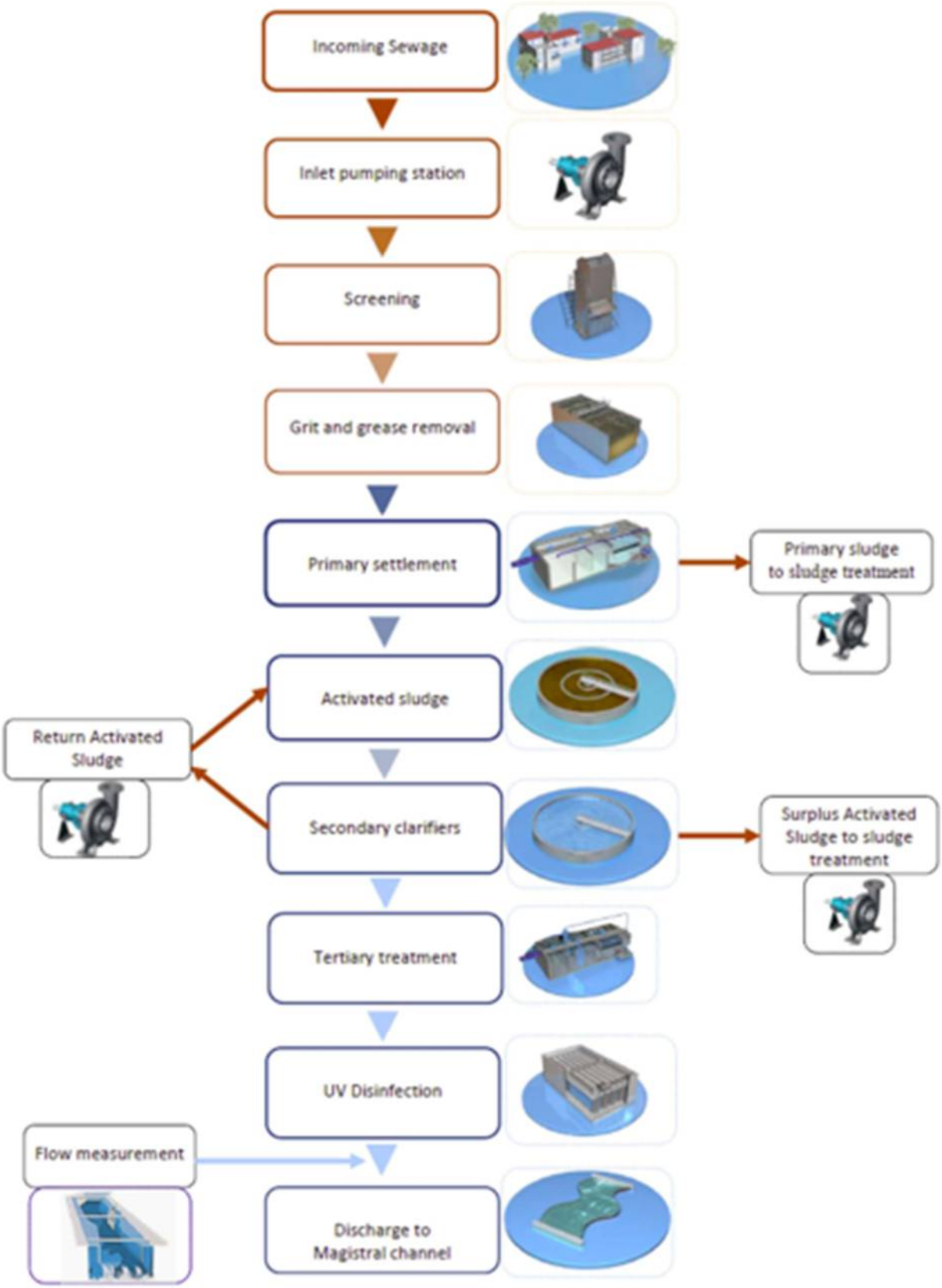


Figure 6-1 Sewage Treatment Flow

Design solutions are developed with the expectation of maximum reliability of the process at any time. Facilities are able to operate and provide the required quality of treatment, while individual machines or blocks are set out of operation, and the project provides reservation at all levels of each process.

General description of technological processes will ensure compliance with the new requirements for quality of treatment for the period until 2021. For this facility, the following technologies were selected, with the following benefits:

• use of lamella primary sedimentation tanks, which are compact and comply with the terms of minimizing footprint;

• biological treatment with activated sludge - traditional technology that is widely used and validated with rich experience of practical application;

• ultraviolet irradiation provides the effective decontamination;

• advanced treatment will remove the remaining contamination for full compliance with the stringent requirements for water quality.

Project facilities are designed to meet the necessary measures to reduce emissions of odors:

• the pretreatment and primary treatment facilities will be covered, which will not allow the spread of odors from their source;

• in buildings housing various treatment systems, adequate ventilation is provided;

• air from the exhaust system is treated for removing odorous components.

6.2.1. Sludge Treatment

The following is a general description of the proposed technological process for sludge treatment facilities of Bortnychi WWTP.

Since the existing sludge fields have almost been filled, it is important to implement a sustainable system of sludge processing and disposal. The proposed process disposes excess sludge by incineration.

Incineration allows to completely step away from discharging sludge into the environment and obtain energy for operation of facilities.

The process flow of sludge treatment and is presented below.

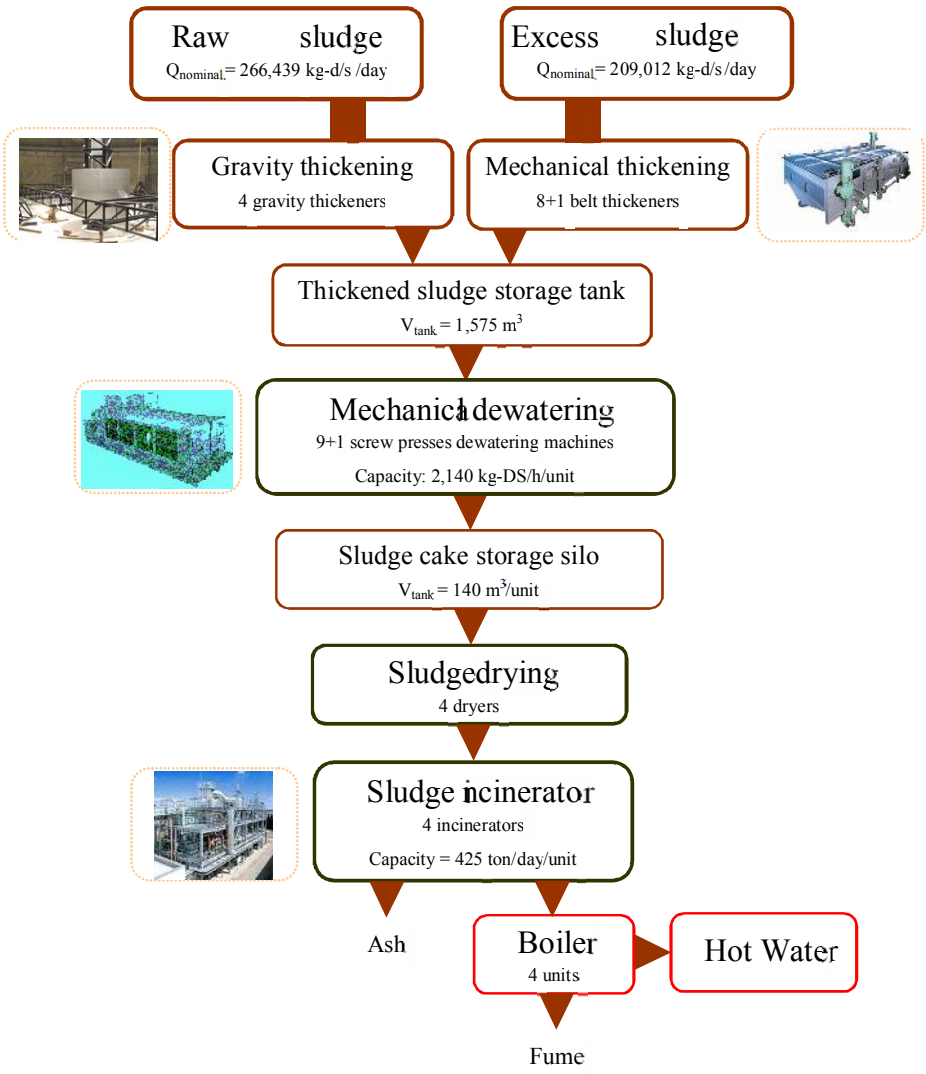


Figure 6-2 General layout of technical processes for sediment treatment and management

(1) Inflow Parameters

The calculation parameters of flow rate and load for the design of sludge treatment system were send for review to Kyivvodokanal and approved on January 29, 2013. These project values of parameters are indicated in the tables below, and the method for their achievement is reviewed in detail in "Description of technical process at water treatment line".

Table 6-1 Project Parameters

Calculation parameter for facilities as a whole	Measurement unit	Value
Average flow rate (for calculation of operation flow rate)	m^3/day	1 123 600
Nominal (maximum) daily flow rate (for design)	m^3/day	1 573 000
Peak hourly flow rate (for hydraulic calculations)	m^3/hr	81 800
Proportion of maximum daily flow rate to average annual flow rate	-	1.4
Proportion of peak hourly flow rate to maximum daily flow rate	-	1.25

Table 6-2 Nominal and average load values

Parameter	Nominal load (kg)	Average load (kg)
$Suspended\ solids_{total}$	416 641	297 601
BOD_5	320 625	229 018
COD	881 289	629 492
N_{total} by Kjeldahl	58 810	42 007
NH_4N	38 406	27 433
$Phosphorous_{total}$	13 203	9 431
$Suspended\ solids_{volatile}$	258 597	184 712
Liquid detergents	220 322	157 373

On the basis of values indicated in the tables above, the calculation of the following sludge treatment volumes was conducted.

Table 6-3 Nominal daily volume of sludge subject to treatment

Description	Measurement unit	Value
Raw sludge		
Concentration	Dry substances, kg/m^3	20
Raw sludge volume	Dry substances, kg/day	266439
	Dry substances, kg /hr	11102
Volatile substances	%	70.4
Sludge volume	m^3/day	13322
Excess sludge		
Concentration	Dry substances, kg/m^3	8
Excess volume	Dry substances, kg/day	209012
	Dry substances, kg	8709

	/hr	
Volatile substances	%	71.9
Sludge volume	m^3/day	26126

(2) **Sludge quality after treatment**

Project solutions are directed at achieving heat equilibrium during sludge incineration.

(3) **Gravity thickening of raw sludge**

Gravity thickeners allow to increase the concentration of raw sludge from several grams of total suspended solids per liter (about 20 g/l) to tens of grams of total suspended solids per liter (about 40 g/l). Under the influence of gravity, solid particles lower to the flat bottom of reservoir. It is a very simple process; no flocculent and great volumes of energy are needed.

For sludge thickening concrete reservoirs with flow crest reverse bridges are used. The separated water flows over the crest located along the perimeter of sludge thickening tanks.

Plough mechanism rakes the sludge on the bottom to the center of the facility. From there, it is pumped to the reservoir for thickened sludge.

The project envisages construction of closed-type sludge thickening equipped with an odor control ventilation system. Ventilated air will be fed into the incineration furnace for full odor control.

(4) **Mechanical thickening of excess sludge**

Surplus activated sludge, i.e. excess sludge, is pumped to the sludge treatment system and supplied to belt thickeners. The pipeline for excess sludge load envisages a point for flocculent introduction. Belt thickeners raise the concentration of solid particles and reduce water content to the level meeting requirements of the next treatment phases.

Belt thickeners consist of the ring line of filtering material to manage three phases of consolidation: conditioning, dehydration and consolidation. After the flocculent is added, flocculated sediments arrive at the moving belt. The water partially flows through the interlacing threads in the belt. Closer to the installation's exit the sludge is additionally thickened with the help of rolls on a flat surface. After such treatment the thickened sludge mostly contain 40 per cent of dry material. Belt thickeners are recommended for use to thicken excess sludge.

The project envisages equipping a reserve line with one belt thickener and one flocculent dosage pump.

(5) Thickened sludge storage tank

In the end of thickening phase, the thickened sludge are unloaded and stored in thickened sludge storage tank.

It is used for storage and full mixing before supplying to mechanical dewatering with the formation of homogeneous sludge mix:

- Thickened raw sludge from gravity thickeners;
- Thickened excess sludge after mechanical thickening (belt thickeners).

Mixing equipment, construction and the method of its installation were chosen with regard to reservoir geometry and provide for obtaining an ideal homogeneous sludge mix.

The pump station supplies the obtained mix to mechanical dewatering.

Table 6-4 Specifications of thickened sludge in the thickened sludge storage tank

Parameter	Measurement unit	Value
Thickened raw sludge		
Thickened raw sludge flow rate	Dry substances, kg/day	226473
Concentration of thickened raw sludge	Dry substances, kg/ m³	40
Volatile substances content in thickened raw sludge	%	70.4
Flow rate of consolidated raw sludge	m³/hr	236
Thickened excess sludge		
Thickened excess sludge flow rate	Dry substances, kg/day	199157
Thickened excess sludge concentration	Dry substances, kg/m³	40
Volatile substances content in thickened excess sludge	%	71.9
flow rate of thickened excess sludge	m³/hr.	207
Thickened sludge		
Thickened sludge flow rate	Dry substances, kg/day	425630
Thickened sludge concentration	Dry substances, kg/m³	40
Volatile substances content in thickened sludge	%	71.1
flow rate of thickened sludge	m³/hr.	443

For the storage of thickened sludge there is a project of closed reservoir with ventilation and polluted air draft to the odor control system.

(6) Mechanical dewatering

Screw press dewatering machines are installed in the facility with mechanical dewatering section.

Screw press dewatering machines are started and stopped in automatic regime, and after the screw-press the dewatering machine is switched off, its load line is washed. On the line of thickened sediments supply for dehydration a selection of samples is organized to measure dry substance concentrations.

(7) **Sludge cake storage silo**

Dewatered sludge is stored in a silo for the storage of dewatered sludge. From this silo, the dewatered sludge supplied to the drying phase.

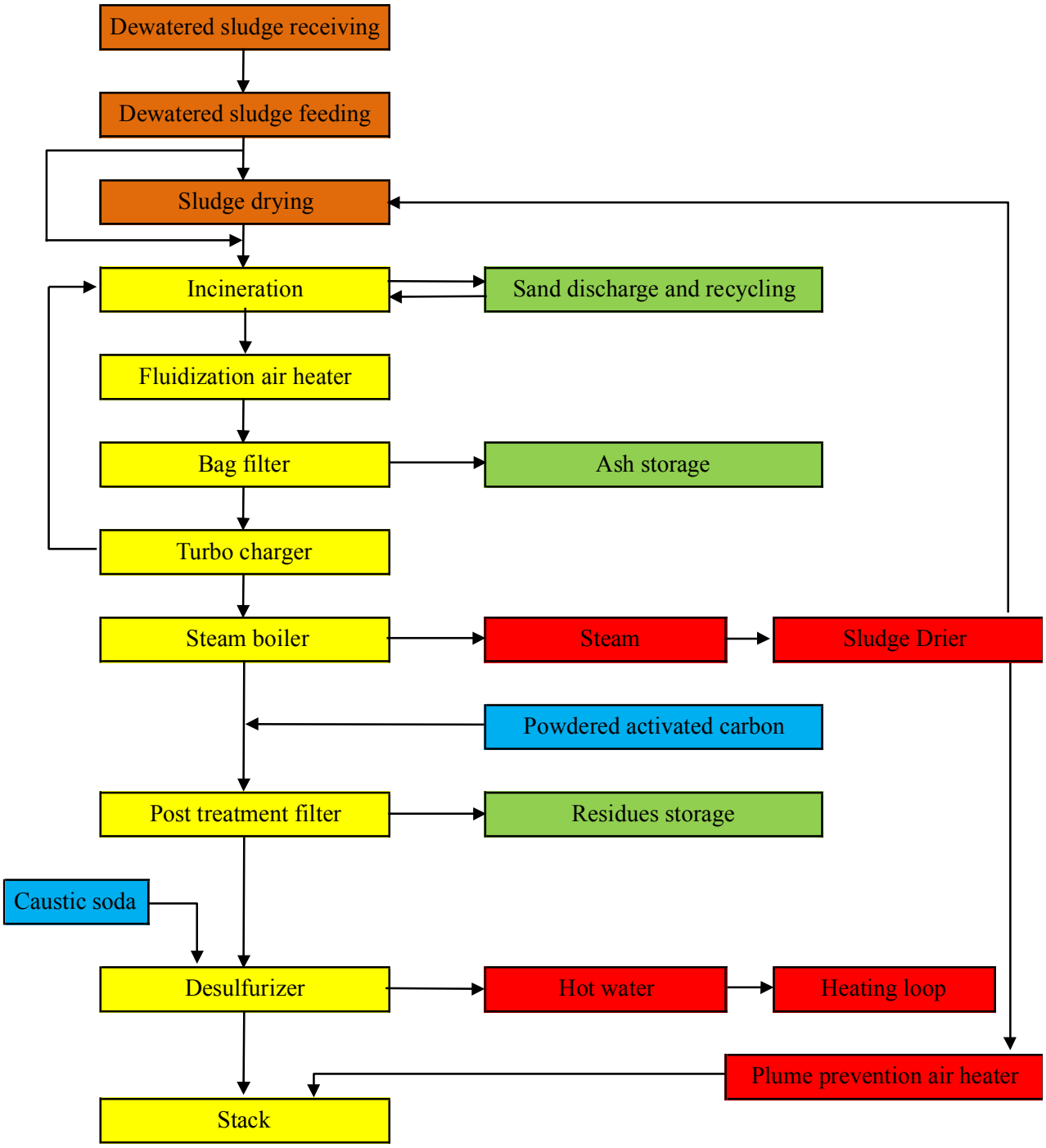


Figure 6-3 Sludge Incineration Process

(8) Sediment drying

After dehydration, the sediments formed during the work of Bortnychi aeration station arrive at the drying system.

In this system, the proportion of dry material in the sediments is raised to the level that permits auto-thermic combustion in furnaces. A minimum volume of sediment required for the overall auto-thermic condition is separated for drying and then afterwards remixed with the balance of the original wet sludge to achieve the overall auto-thermic conditions. The driers of indirect drying shall be developed specifically for the drying process of sludge.

Steam is used for heating; this steam shall be generated by waste heat boiler installed in the incinerator flue gas heat recovery line. The drain water after heating will be recycled into the waste heat boiler.

The mixed sludge is pumped to the respective incineration line.

(9) Sediment incineration

Pressurized Fluidized bed technology is used in the incineration process with the following features:

- Highly turbulent, even temperature gradient, intensive and steady incineration process ensuring near complete burning of organic matter;
- Under positive pressure, oxidation reaction between oxygen and combustible shall be effectively activated in the furnace. Thus complete burning of organic matter shall be further accelerated;
- The activated oxidization reaction will materialize in partial high temperature zone appears in the incinerator. This phenomena reduce N_2O (a GHG, approximately 300 times in green house value than CO_2) concentration;
- Combustion temperature of 850-900^oC, ensuring longer lifetime of the incinerator and low NO_x emissions;
- Intensive heat transfer within the fluidized bed, allowing decreasing of the heat exchanging surface and reducing the installation size;
- Operational flexibility;

- No moving parts inside the incineration chamber ensuring its longer lifetime.

The pre-drying ensures auto-thermal conditions in the furnace. However, the incineration system is equipped with support guns to be started automatically to sustain the required temperature, as well as supporting facilities for stand-by, start-up and shut-down procedures. Natural gas may be used as feed material for these support guns.

Whole odor such as non-condensing air discharged from the dryer facility and odor from sludge thickening and dewatering facilities are sent into the furnaces for incineration. In case where incinerators are not operating, odor will be induced into emergency de-odorization facility with activate carbon filters and discharged to atmosphere after treatment.

(10) Heat recuperation system

The facilities will include a heat recovery system, consisting in two heat exchangers installed on the flue gas outlet in order to:

Pre-heat the fluidization air for the incinerator (with the first heat exchanger) , auto thermal conditions are easy to reach.

Produce steam for the pre-drying system and plume prevention system (with the waste heat boiler);

Flue gas is treated by water scrubbing tower, and produced hot waste water heat is recovered (with the warm water heat exchanger). Moreover the recovered hot water temperature is heated up by using excess steam from the waste heat boiler and then utilized as heating source of building.

(11) Flue gas treatment system

The flue gas treatment system will be a wet type system to avoid increasing amount of residue. The flue gas cleaning system eliminates ashes, acidic gases: HCl, SOx, HF and, heavy metals and NOx to comply with the emission regulations and requirements.

The first stage of the treatment is the removal of ash/dust from the flue gas stream. The ash/dust separator is a hot bag filter. The flue gases treatment system includes pneumatic transport of ash to storage silos.

The second stage of treatment is removal of heavy metal, especially mercury. Powdered activated carbon is injected into the flue gas and the residue is collected by the post treatment filters.

The third stage of treating is the removal of remaining ash/dust, acidic gases and heavy metals from the flue stream. A wet scrubber is applied for the third stage treatment. The pollutants are absorbed into sprayed water and to keep pollutants removal efficiency adequately, sprayed water pH is neutralized by caustic soda injection.

After the third stage treatment, the flue gas temperature is raised by mixing plume prevention hot air, Then heat up flue gas goes out to the atmosphere by its own pressure without blower through stack.

At the moment of their discharge into the atmosphere, treated flue gas shall meet the following emission standards;

Table 6-5 Flue Gas Specifications for Discharge To The Atmosphere

Component	Concentration in flue gases (mg/Nm^3*) according to EU standards, 10% O2	Concentration in flue gases (mg/Nm^3*), 6% O_2	Emission Standard according to Ministry of Nature regulation No. 309 of 27.07.2006
CO	50	68	250
Dust (total)	10	13,6	150
Total organic carbons	10	13,6	Not Regulated
HCl	10	13,6	Not Regulated
HF	1	1,4	5
SO_2	50	68	Not Regulated
NO_x	200	272	500
Cd + Ti	0.05	0,07	0,2
Hg	0.05	0,07	0,2
Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V	0.5	0,07	0,2
Dioxins and furans	0.1 ng/Nm^3	0,14ng/Nm^3	20

* Maximum average values for the period of 24 hours per 1 Nm^3 of dry gas containing 11% O_2

(12) Steam Generation

The waste heat boiler is installed in the flue gas heat recovery line, then steam is generated for the sludge drying and plume prevention air heating. The major part of the pressured steam is used to provide energy to the dryer.

(13) Axillary Facilities

Apart from the aforementioned systems, the facilities will include all systems and equipment necessary for start-up and proper operation, such as:

- Boiler water softener system, ion exchanger type,

- Reagent storage and dosage system;
- Compressed air system;
- Cooling systems (flue gas, desulfurizer circulation water)

(14) General Specification

Project specifications of drying and incineration systems are based on the presumed parameters as shown in Table 6-6.

Table 6-6 General Conditions and Specifications

Parameter	Measurement unit	Value
Flow rate of sediment supply (total)	Dry substances, kg / day	408,392
Content of volatile substances in supplied sediments	% dry substances	71.1
Necessary content of dry substances in supplied sediments to provide for heat balance in the incineration system	%	26.4
Heating coefficient of supplied sediments	kcal/kg volatile substances	5,600
Heating coefficient of supplied sediments	kcal/kg raw substances	3,982
Furnace work regime	hr/day	24
Furnace work regime	days/week.	7
Number of incineration line	-	4
Number of operating lines (average load)	-	3
Type of furnace	-	PFBI
Average fuel consumption for normal work (total)	Nm^3/hr	Only when the "cold" start (first start or after the start of the annual maintenance)
Flow rate of pseudo-liquid air (total)	Nm^3/hr	88,876
Average fluidization air flow rate	Nm^3/hr	63,483
Flow rate of flue gases (total)	Nm^3/hr	164,772
T° of flue gases at the entry to pseudo-liquid air heater	°C	850
T° of flue gases at the exit from air heater	°C	607
T° of pseudo-liquid air at the heater exits	°C	650
T° of flue gases at the boiler	°C	479
T° of flue gases at the boiler exit	°C	245
Volume of vapor from the boiler (total)	t/hr	25.2

(15) **Flue Gases Treatment**

The methods to utilize ash extracted from flue gases at the bag filter are reviewed in a document dedicated to the analysis of ash utilization possibilities.

Table 6-7 Bag Filter and Ash Utilization

Parameter	Measurement unit	Value
Number of lines		4
Flow rate of flue gases (total)	Nm^3/hr	164,772
Bag filter outlet dust	g/Nm^3-dry	0.02
Pressure drop at bag filter	mm H_2O	200
Volume of ash formation (total)	t/hr	4.92
Ash density	t/m^3	0.6
Volume of formed ash (total)	m^3/day	196.4
Volume for storage	m^3	$80m^3$*8nos.
Reserve capacity	day	3.0

Table 6-8 Post Treatment Filter and Residue Storage

Parameter	Measurement unit	Value
Number of lanes	-	4
Average flow rate of flue gases (total)	Nm^3/hr	168,372
Absorbent carbon dose	mg/m^3	100
Consumption of absorbent carbon (total)	t/day	0.77
Consumption of absorbent carbon at daily mean waste water flow	t/day	0.55
Density of absorbent carbon	t/m^3	0.4
Flow rate of absorbent carbon (total)	m^3/day	1.9
Flow rate of absorbent carbon at daily mean waste water flow	m^3/day	1.36
Volume of absorbent carbon storage bunker	m^3	$1m^3$*36nos.
Reserve capacity	day	18

Post treatment filter solid waste shall be removed separately from the ash removed in the bag filter as this waste contains chemical substances and therefore cannot be utilized.

Post treatment filter solid waste should be placed in specially designed spots where pollutants cannot get into underground waters.

Table 6-9 Chemical Injection at Desulfurizer and Storage

Parameter	Measurement unit	Value
Flow rate of flue gases (total)	Nm^3/hr	168,372
Flue gases temperature	°C	245
Caustic soda concentration	%	48
Caustic soda density	T/m^3	1.5

Caustic soda consumption	m^3/day	8.9
Caustic soda consumption at daily mean waste water flow	m^3/day	6.4
Caustic soda tank capacity	m^3	$7m^3$*4nos.
Storage capacity	Day	3

Table 6-10 Exhauster of Flue Gases Discharge and Funnel

Parameter	Measurement unit	Value
Number of stack	-	4
Flue gas flow rate	Nm^3/hr	156,416
	Nm^3/hr/unit	39,104
Flue gas temperature	°C	73.5<
Funnel diameter	m	1.2
Gas flow speed in the funnel	m/s	12
Stack Height	m	28

Below, we provide the calculation of annual consumption values for resources, chemical reagents, factory supplies and power at Bortnychi aeration station after reconstruction, which will be conducted to adhere to the new norms of treatment quality, with regard to forecasted load for the period until 2021.

(16) Underlying Project Parameters

The project of water treatment line has been developed on the basis of the following original data:

- Maximal daily water flow rate (nominal) – 1,573,000 m^3/day.
- Average daily water flow rate – 1,123,600 m^3/day.
- Maximal hourly water flow rate – 818,000 m^3 / hr

Average load is determined by dividing nominal load by the proportion of maximum flow rate by a factor of 1.4.

Yearly consumption values indicated below correspond to the operation of facilities with the expected annual load level (i.e., average daily load x 365 days).

In the following Table, nominal (maximum daily) values and average load values for all facilities in general are provided.

Table 6-11 Project Parameters

Parameter	Nominal load (kg / day)	Average load (kg / day)

Total suspended solids	416 641	297 601
BOD_5	320 625	229 018
COD	881 289	629 492
Total nitrogen by Kjeldahl	58 810	42 007
NH_4N	38 406	27 433
Total phosphorus	13 203	9 431
Total suspended solids, volatile	258 597	184 712
Liquid detergents	220 322	157 373

On the basis of the data provided above, the calculation of sediment formation on facilities was done.

Table 6-12 Sludge Parameters

Raw sludge	Nominal flow rate (dry materials, kg / day)	Average flow rate (dry materials, kg / hr)	Volatile substances / dry materials (%)
Raw sludge	266 439	190 314	70.4
Surplus active sludge	209 012	149 294	71.9
Total	**475 451**	**339 608**	**71.1**

(17) Consumption of Chemical Reagents and Other Materials

Below, we provide the data on consumption of chemical reagents for wastewater treatment, sediment processing and odor control system.

Table 6-13 Consumption of Chemical Reagents and Other Materials

Reagent	Consumption	Measurement unit	Average value
FeCl3 - 40% Liquid	Removal of phosphorus from water - dose	mg / l	35
	Removal of phosphorus from water – reagent flow rate	t / year	35884
Micro-sand	Additional water treatment – sand concentration	g/m^3	7
	Additional water treatment – sand flow rate	t / yr	299300
Anionic flocculent, in powder	Additional water treatment – flocculent dose	mg / l	1
	Additional water treatment – flocculent flow rate	t / yr by commodity product	410
Cationic polymeric material, in powder	Mechanical thickening of excess sludge. Flocculent dose	g / dry materials, kg by commodity product	3
	Mechanical thickening of excess sludge. Flocculent flow rate	t / yr by commodity product	163
	Mechanical dewatering. Flocculent	g / dry materials, kg by	10

	dose	commodity product	
	Mechanical dewatering. Flocculent flow rate	t / yr by commodity product	1 110
	Total flocculent flow rate for sediment treatment	t / yr by commodity product	1 273
Absorbent carbon, in granules	Odor control – Water treatment line	t / yr	48
Absorbent carbon, in powder	Sludge treatment line - incineration	t / yr	200
Caustic soda	Sludge treatment line - incineration	t/yr	3 481

The wastewater generated after treating flue gas undergoes desulfurization, after which it is pumped to the beginning of the BSA wastewater treatment process.

The chemical quality of water after flue gas treatment:

1. Volume

- Drainage of the lower stage

Flow rate 2100 kg/h. Temp. 73.5 ℃. Calorific value 646.3 MJ/h

- Drainage of the upper stage

Flow rate 214 801 kg/h. Temp. 50 ℃ Calorific value 44 957,8 MJ/h

- Total 216 901 kg/h

2. Expected Na_2SO_4 concentration

During desulfurization, H_2S is neutralized by adding NaOH as a neutralizer, and thus, the content of Na_2SO^4 is calculated at the level specified in the table below.

Expected sulfur content in volatile substances (VS) of sludge: 0.93%.

Sulfur in sludge: 28 kg-S/h/line, therefore, Na_2SO_4 reaches 124 kg/h

Desulfurizer wastewater: 216 901 l/h

Concentration of Na_2SO_3: 0.057 g/100 mL

Since the solubility of Na_2SO_4 is 4.76 g/100 ml (at 0 ^oC), Na_2SO_4 is considered soluble in wastewater.

3. Other substances

Other substances, the content of which is expected in the desulfurizer wastewater, are listed in the table below.

Table 6-14. Design quality of desulfurizer water

Component	Unit	Design indicator
pH	-	6-7
Suspended solids	mg/l	10-20
COD_{Mn}	mg/l	10-40
BOD	mg/l	15
materials from which n-hexane is derived (index to determine lubricants)	mg/l	2-6
T-Hg	mg/l	ND <0.0005
alkyl mercury	mg/l	ND <0.0005
Cadmium (Cd) and its compounds	mg/l	ND <0.001

Lead (Pb) and its compounds	mg/l	ND <0.005
Cr^{6+}	mg/l	ND <0.03
Arsenic (As) and its compounds	mg/l	0.01
Organic phosphorus compounds	mg/l	ND <0.01
Cyianides	mg/l	0.08
Polychlorinated biphenyls	mg/l	ND <0.0005
Selenium (Se) and its compounds	mg/l	ND <0.01

(18) WATER CONSUMPTION

Listed below are the amounts of consumption of potable and process water for treatment for water and sludge, as well as operation of deodorization system.

Water consumption **from municipal water supply** - 2954.96 m^3/h

Including: - Staff and drinking needs - 176.26 m^3/day

- Technological needs (equipment washing, floor cleaning) - 81.76 m^3/day
- Technological needs (flocculants) - 1792 m^3/day
- Circulation system (feed water) - 14,58 m^3/day
- Plant watering - 890,36 m^3/day

Water consumption **from main discharge channel** - 7334.87 m^3/h

Including:

- Technological needs (coagulant dilution) - 61.87 m^3/day
- Technological needs (equipment washing) - 48.25 m^3/day
- Feeding recirculation water for flue gas treatment system - 2448 m^3/day
- Sewage - 7531.02 m^3/h
- Unbalance in staff and drinking water - 2696.94 m^3/day, incl.:
- Plant watering, road and sidewalk cleaning - 890,36 m^3/day
- Technological needs (flocculant dilution) - 1792 m^3/day
- Circulation system (feed water) - 14,58 m^3/day

Unbalance in technical water - 61.87 m^3/day, incl.:

- coagulant dilution - 61.87 m^3/day

(19) POWER CONSUMPTION AND PRODUCTION

The table below specifies the consumption and generation of electricity at BSA after rehabilitation in case of moderate load.

Table 6-15 Electric Energy Consumption

Name of load	Calculated load MW
Component 1	6.86
Component 2	1.8
Component 3	6.47
Component 4	8.74
Component 6	3.53
Component 8	7.59
Component 9	5.57
Component 10	1.68
BSA Total	**42.25**
Component 7 - "Right Bank" Pumping Station	7.4

To determine total consumption and respective operation expenses for aeration station in general, it is necessary to also include the following consuming equipment in the calculation:

- Pump stations;
- Reconstructed portion of Block 3 (including air blowers);
- Heating, ventilation and air conditioning systems in other buildings (administrative and working).

Power supply: the objects of Bortnychi aeration station are connected to energy supply systems and networks. All station boundaries are connected to the working city and district networks.

The territory of BAS is provided by working electric supply networks. On the same territory, transformer electrical substations.

There are also working water supply, sewage and heating networks, as well as technical engineering networks, communications and dispatch systems. The usage of potable and sweetened water for discharge and sediment treatment as well as odor control system amounts to 505118 m^3/yr.

Labor resources during construction and operation are allocated according to staff schedule.

(20) Ventilation air odor control

According to terms of reference from the client of October 18, 2012, for the protection of air environment from odorous pollutants, the project envisages odor control for the air removed from reservoir facilities and ribbon consolidator covers, skips, grease collector, distribution channel and also from covers over the water surface of channels with screens, sand collectors, primary settling tanks and local covers of the screens themselves and debris conveyor. Such substances are hydrogen sulfide, ammonia, and mercaptan. With regard to the composition of pollutions, out of many methods of odor control the project envisages absorption method as the most efficient and the cheapest by capital and operation expenses.

As absorbents, air filters with absorbent carbon are used. Before these filters, thin mechanic filters are envisaged to extend the service life of carbon filters.

6.3. Scope of Environmental Impacts Assessment During Operation Phase

The elements of activities that may affect environment are as follows:

- Hydro-geology,
- Land resources and landscapes,
- Air environment,
- Aquatic environment,
- Waste generation,
- Climate and micro-climate,
- Flora and fauna (Ecosystem),
- Nature reserves,
- Electromagnetic field,
- Noise and vibrations,
- Infrastructures and artificial objects,
- Local economy and society,
- Resettlement, and
- Accidents and diseases.

In the following sections of 6.3.1 through 6.3.14, each of the above items is assessed preliminarily to determine the need for further thorough impact assessments to be described in Chapter 7

6.3.1. Impact on Hydro-geological environment

Design solutions provide construction of underground facilities that are waterproof, so their operation will not affect the state of hydro -geological environment.

Ground subsidence is not risk because there is no planned extraction of groundwater for the project. None of wastes to be generated will be disposed directly to ground. Therefore, there is no risk of soil or ground water contamination.

The current sludge disposal sites constructed prior may pose some risk of groundwater soil contamination due to its rudimentary designs. However, the project will eliminate the continued to stockpiling of sludge in these fields after the commissioning of the planned incinerators. Thus, the project will greatly reduce the risks associated

6.3.2. Use of Land Resources, Landscape

The land proposed during the reconstruction works of wastewater sewage and building technological line for processing and disposal of sludge of Bortnychi WWTP is located in the northwestern part of the village of Bortnychi and is the southeastern part of Kyiv. For a long time, the land plot has had facilities that are subject to removal.

As a result of reconstruction on the earth resources is made some influence is limited to minor changes in the natural terrain of the land within the allotment. The current method of stockpiling of sludge in the sludge fields will necessitate additional sludge fields and embankments to be established for ever growing stock of sludges which cannot be recycled. Thus the project will eleminate theneeds for further reallocations of land resources for the continued operation . More detailed assessment is deemed to be unnecessary.

6.3.3. Impact on Air Environment

The current sewage treatment operations emit unpleasant odors beyond the premise of BAS which will be improved significantly after reconstruction. The sources of pollutants after reconstruction in the atmosphere will include chimneys of designed installations of incineration of sludge, industrial ventilation systems of technology areas, DVZ vehicles.

6.3.4. Impact on Aquatic environment

Treated wastewater is discharged into the main channel, and pumped into the river of Dnipro. The quality of treatment must conform to the requirements for waters of cultural and community purpose. Design solution provides organization of removal and treatment of surface effluent from areas of open parking lots. Discharge of treated wastewater is provided

into the existing network of rainwater sewer. For drinking purposes there are used existing sources of water - municipal networks.

6.3.5. Waste Generation

As a result of industrial activity there will be generated waste utilities, sludge from wastewater treatment, residues, obtained during the extraction of sand, remains of trimming trees, ferrous and non-ferrous metals, cleaning cloths, waste from servicing machinery and mechanisms, household waste, and others.

6.3.6. Impact on Climate and Micro-climate

the current operations and operations to be introduced by the Project both will emit the greenhouse gasses of carbon dioxides, methane. However, the total effects will be likely to reduce.

Under the current scheme of operations, the estimated annual emission of carbon oxides and methane are 4.5 tons and 315 tons respectively. After reconstruction, the values change to 148 tons of carbon oxides and 108 tons of methane. In terms of greenhouse gas effects, the carbon dioxides equivalent values change from 7880 tons to 2850 tons, indicating significant reduction in global warming impacts. More detailed assessment is deemed to be unnecessary.

6.3.7. Impact on Flora and Fauna

The designed activities are not connected with large-scale removal of green space. Minor violations of vegetation (self-seeding) during the reconstruction of buildings, replacement and laying of pipelines will be offset by planting trees of valuable species by a special section of gardening and landscaping of BAS during the scheduled work.

Species belonging to the kinds of national importance or which are listed as endangered are missing. As a result of cutting the soil-vegetation layer, vegetation is disturbed.

There has been no change in habitat associated with urbanization of the area and the operations of BAS in the past. As a result of constructing the proposed facilities, no negative impact on wildlife will be made, since it excludes use of additional land that would reduce the area of their existence. More detailed assessment is deemed to be unnecessary.

6.3.8. Protection of Nature Reserves

There is no parks or natural reserves within the Project site or in its vicinity to be protected from influences for the Project. More detailed assessment is deemed to be unnecessary.

6.3.9. Electromagnetic Field Impact

Electromagnetic non-ionizing radiation will emanate from the electric fields around substation equipment and conductors. However, the anticipated impact is minimal because only extremely low frequency fields are generated from substations. More detailed assessment is deemed to be unnecessary.

6.3.10. Noise and Vibrations

There will be some motor, pump noises generated for the operation of sewage treatment. However, the noise level will be contained within the buildings of BAS. the caution may be taken for the protection of labor safety. More detailed assessment is deemed to be unnecessary.

6.3.11. Impact on Infrastructures and Artificial Objects

Given thenature of the Project, i. e. rehabiliation, the Project does not impose any extra load on the existing infrastrucutres except for the period of construction.

The current method of stockpiling of sludge in the sludge fields will necessitate additional sludge fields and embankments to be established for ever growing stock of sludges which cannot be recycled. Thus the project will eleminate theneeds for continuous sludge field development.

More detailed assessment is deemed to be unnecessary.

6.3.12. Impact on Local Economy and Society

The influent water to the BAS is only sewage to be treated thus there is no infringment of water rights of other memebers of society. There is no extra allocation of natural resources specific to the project, thus there is no direct impact on local economy. There is no significant objects of cultural and historical importance within the Project area. The organization to operate the planned facilities of BAS is alreay operational since the project is largely rehabilitation in nature. Thus the Project poses no conflict of interest or requirements of instituaitonal changes. Total number of the BAS staff will be about 900 people. Technological solutions provide observance of standards of industrial sanitation, and improved working environment through proposed processes.

More detailed assessment is deemed to be unnecessary.

6.3.13. Resettlement

The Project does not require additional significant space for land.

More detailed assessment is deemed to be unnecessary.

6.3.14. Accidents and Disease

- Fire
- Electroexecution
- Traffic Accidents
- Public health

Actual planning and development of manuals, instructions, and awareness raising program should be developed during the detail design stage. Actual training and supervision should be carried out according to the developed plans during the time of commissioning.

6.4. Scope of Environmental Impacts Assessment During Construction Phase

The elements of activities during construction phased that may affect environment are as follows:

- Hydro-geology,
- Land resources and landscapes,
- Air environment,
- Aquatic environment,
- Waste generation,
- Climate and micro-climate,
- Flora and fauna,
- Nature reserves,
- Electromagnetic field,
- Noise and vibrations,
- Infrastructures and artificial objects,
- Local economy and society,
- Resettlement, and
- Accidents and diseases.

In the following sections of 6.4.1 through 6.4.14, each of the above items is assessed preliminarily to determine the need for further thorough impact assessments to be described in Chapter 7.

6.4.1. Impact on Hydro-geological environment

The operation does not affect aquifer. More detailed assessment is deemed to be unnecessary. The monitoring of groundwater will be proposed to make sure proper construction.

6.4.2. Use of Land Resources, Landscape

A somewhat large scale of laborforce will be deployed during the period of construction. there will be a need for labor camp which will be elected within estalishments. More detailed assessment is deemed to be unnecessary.

6.4.3. Impact on Air Environment

Construction activities will generate minor volumes of dust and other pollutants.

The current operation of BAS will emanate odors during the construction period. Despite minor impacts, the Ukrainian law requires the full assessment of air impacts by construction machinery.

6.4.4. Impact on Aquatic environment

Construction activities will generate minor volumes of waste water by washing of construction and transport machinery without significant impacts. Water supply and sewerage service will be provided to the labor camp for construction. More detailed assessment is deemed to be unnecessary.

6.4.5. Waste Generation

Construction waste will be generated in a minor quantity during dismantling. Dismantled concrete, metal scraps and other wastes may be generated in a minor quantity due to construction activities by heavy and transport machines.

6.4.6. Impact on Climate and Micro-climate

There will be minor emission of greenhouse gasses without significant impacts mostly by transport vehicles.

6.4.7. Impact on Flora and Fauna

There will be no impacts on wild life or vegetation during construction. More detailed assessment is deemed to be unnecessary.

6.4.8. Protection of Nature Reserves

There is no nature reserves or parks infringed by construction activities. More detailed assessment is deemed to be unnecessary.

6.4.9. Electromagnetic Field Impact

No construction activities will emanate significant electromagnetic radiation. More detailed assessment is deemed to be unnecessary.

6.4.10. Noise and Vibrations

Construction activities will generate minor volumes of noise and vibrations without significant impacts. Despite minor impacts, the Ukrainian law requires the assessment of noise and vibration impacts by construction machinery.

6.4.11. Impact on Infrastructures and Artificial Objects

Higher volumes of traffic during construction may pose extra loads on road infrastructures. However, the location of BAS at the end of a feeder road, there is no significant traffic jams to be expected in the vicity. More detailed assessment is deemed to be unnecessary.

6.4.12. Impact on Local Economy and Society

Construction activities are expected to generate more jobs and induced consumption to provide positive impacts to local economy. The organization to operate the planned facilities of BAS is alreay operational since the project is largely rehabilitation in nature. Thus the Project poses no conflict of interest or requirements of instituaitonal changes.

More detailed assessment is deemed to be unnecessary.

6.4.13. Resettlement

The space required for labor camp for construction can be allocated within the premise of BAS. More detailed assessment is deemed to be unnecessary.

6.4.14. Accidents and Disease

Large-scale construction activities will require careful planning and prevention measures for worker safety and health as follows:

- Protection from falling and objects falling
- Fire
- Electroexecution
- Traffic Accidents
- Infectious Diseases

Actual planning and development of manuals, instructions, and awareness raising program should be developed during the detail design stage. Actual training and supervision should be carried out according to the developed plans during the time of construction.

- All the questions, suggestions and remarks of the public, expressed during discussion process, both in oral and written form, were collected for further processing. All information, obtained in course of the public discussion, was systematized and

analyzed for consideration in further activities of Bortnychi aeration station by PJSC "Kyivvodokanal".

7. ASSESSMENT OF IMPACT OF PLANNED ACTIVITIES ON ENVIRONMENT

This chapter presents the full assessment of environmental impacts for the scopes of environmental impacts assessment defined in 6.3 for operations and 6.4 during construction.

7.1. Air Environment

7.1.1. Ambient Concentration Standards

Table 7-1 Maximum Permissible Pollutant Concentration Standards

Contaminating substance	Code	Maximum Permissible Concentrations mg/m^3
Aluminum oxide	101	0.100000
Vanadium pentoxide (Vanadium and compounds)	110	0.020000
Iron oxide** (Fe)	123	0.400000
Cadmium oxide (Cd)	133	0.003000
Manganese and compounds (in in terms of manganese dioxide)	143	0.010000
Sodium hydroxide (Sodium caustic, soda caustic)	150	0.010000
Sodium carbonate (Baking soda)	155	0.040000
Mercury metallic (Mercury and compounds)	183	0.003000
Lead and compounds, except lead tetra-ethyl lead	184	0.001000
Chrome hexavalent (in equivalent to trioxide)	203	0.002000
Nitrogen dioxide	301	0.200000*
Nitrogen acid on molecule HNO_3 (Hydrogen nitrate)	302	0.400000
Ammonia	303	0.200000
Nitric oxide	304	0.400000
Hydrogen chloride (chlorine hydride) on molecule HCl	316	0.200000
Sulfuric acid on moleculeH_2SO_4	322	0.300000
Silicon dioxide non-crystalline (aerosil-175)	323	0.020000
Colloidal carbon	328	0.150000
Sulfur dioxide	330	0.500000
Hydrogen sulfide (hydrogen sulfide)	333	0.008000
Carbon oxide	337	5.000000
Fluorous gaseous compounds (hydrofluoric acid, 4-fluorosilicone)	342	0.020000
Highly soluble non-organic fluoric substances (sodium fluoride and hex.)	343	0.030000
Non-highly soluble non-organic fluoric substances (aluminum and calcium fluoride)	344	0.200000
Hexane	403	60.000000
Methane	410	50.000000
Benzene	602	1.500000
Xylene	616	0.200000
Benzo(a)pyren	703	0.000010
Chlorodifluoromethane (freon-22)	859	100.000000
Isopropyl alcohol	1051	0.600000
Ethyl alcohol	1061	5.000000
Methylmercapan	1715	0.000100
Ethanethiol (Ethyl mercaptan)	1728	0.000030
Kerosene	2732	1.200000
Petroleum-based mineral oil (spindle, machine, cylinder and other oils)	2735	0.050000
Synthetic detergent type “lotus”	2744	0.030000
Skellysolve	2754	0.200000

Contaminating substance	Code	Maximum Permissible Concentrations mg/m^3
Mineral spirit	2752	1.000000
Hydro-carbon-saturate from 12-to19 (solvent RPK-265 and others)	2754	1.000000
Suspended solids, not differentiated by content	2902	0.500000
Poly-acrylamid-cationic ak-617	10161	0.250000
Titanium Dioxides	10226	0.500000
Emulsol	10265	0.050000
Wooden dust	10293	0.100000
Dust abrasive-metallic	10431	0.300000

Notes: Maximum permissible (one-time) concentration of the chemical in the air in populated areas, which, if inhaled during over 30.0 minutes, does not cause reflex reactions in humans, mg/m^3.

7.1.2. Indicators and Criteria for Assessment of Atmosphere

A mandatory requirement of admissibility of the design facility operation is adherence to standards of environmental safety of air. Main criterion for assessing the air quality in determining the level of direct influence of pollutant emission is the calculated concentration in the buffer zone of hygienic standards of maximum single permissible concentrations (MPC) of pollutants in the atmospheric air under MSPC list, approved by the Chief Sanitary Doctor of Ukraine.

For each of the pollutants emitted into the atmosphere there the following conditions must be met:

$$\frac{C_M}{MPC} \leq 1$$

where: $C_м$ - maximum calculated surface concentrations of pollutants in atmospheric air, mg/m3;

MPC - maximum permissible surface concentrations of pollutants in the atmospheric air, mg/m3;

Note: Maximum permissible one-time concentration of the chemical in the air in populated areas, which, if inhaled during over 30.0 minutes, does not cause reflex reactions in humans, mg/m^3.

Measurement of atmospheric pollution by other sources that have impact on atmospheric air quality in the region is carried out by using background concentration C_f (mg/m^3). This should be carried out by ratios:

$$\frac{C_M + C_f}{MPC} \leq 1$$

The volume of pollutant emissions from the proposed facility on the basis of background polluting and dispersion of pollution in the atmosphere should ensure environmental safety of atmospheric air, i. e. , the maximum allowable surface concentrations, excluding the negative impact on the environment.

7.1.3. Background Ambient Concentration of Pollutants

Atmospheric air quality is characterized by background concentrations of pollutants compared to the maximum single permissible concentration (MSPC). Background concentrations are determined according to the fixed observation posts as a concentration level that is exceeded by no more than 5% of case from the total number of observations.

The values of the background concentrations of pollutants in the atmospheric air for BAS, which the reconstruction provides, are adopted in accordance with the requirements of the order of the Ministry of Environment of Ukraine № 286 30.07.2001. Observation of atmospheric air pollution in Kyiv is conducted by the Central Geophysical Observatory at 16 fixed positions. Values of background concentrations are provided under CGO of 12.09.2013, № 16-13/2382/05-672 in Table 7-2.

Table 7-2 - Background Ambient Concentrations in 2013

Conditional coordinates	Pollutant	Concentration	
		mg/m^3	Factor of MPC
In the city of Kiev	Sulfur dioxide	0.0279	0.06
	Carbon monoxide	2.8829	0.58
	Nitrogen dioxide	0.1830	0.92
	Nitric oxide	0.0365	0.09
	Dust (suspended matter)	0.1850	0.37
	Hydrogen fluoride	0.0038	0.19
	Hydrogen sulfide	0.0025	0.31
	Hydrogen chloride	0.1034	0.52
	Ammonia	0.0203	0.10

Note: For other substances the background concentrations are considered at 0.4 MPC.

7.1.4. Current Ambient Pollutant Concentrations

The nearest two monitoring sites at the BAS are shown in the Figure 7-1 below and the table below shows the latest results.

Figure 7-1 Location of air quality monitoring points near the BAS

The results in Table 7-3 show that some parameters such as NO_2, NH_3 and H_2S exceed the maximum permissible concentration (MPC) of Ukraine.

Table 7-3 Results of air quality monitoring near BAS

Measuring unit: mg/m3

Parameter	Monitoring location 1		Monitoring location 2		MPC
	29.04.2013	04.07.2013	29.04.2013	04.07.2013	
SO2	0.2	0.4	0.2	0.3	0.5
NO2	0.1	0.1	0.090	0.094	0.2
NH3	0.5	0.3	0.4	0.2	0.2
CH2O	0.011	0.017	0.006	0.012	0.035
H2S	0.1	0.18	0.1	0.13	0.008
CO	4.4	5.0	3.5	4.1	5.0

Source: KVK

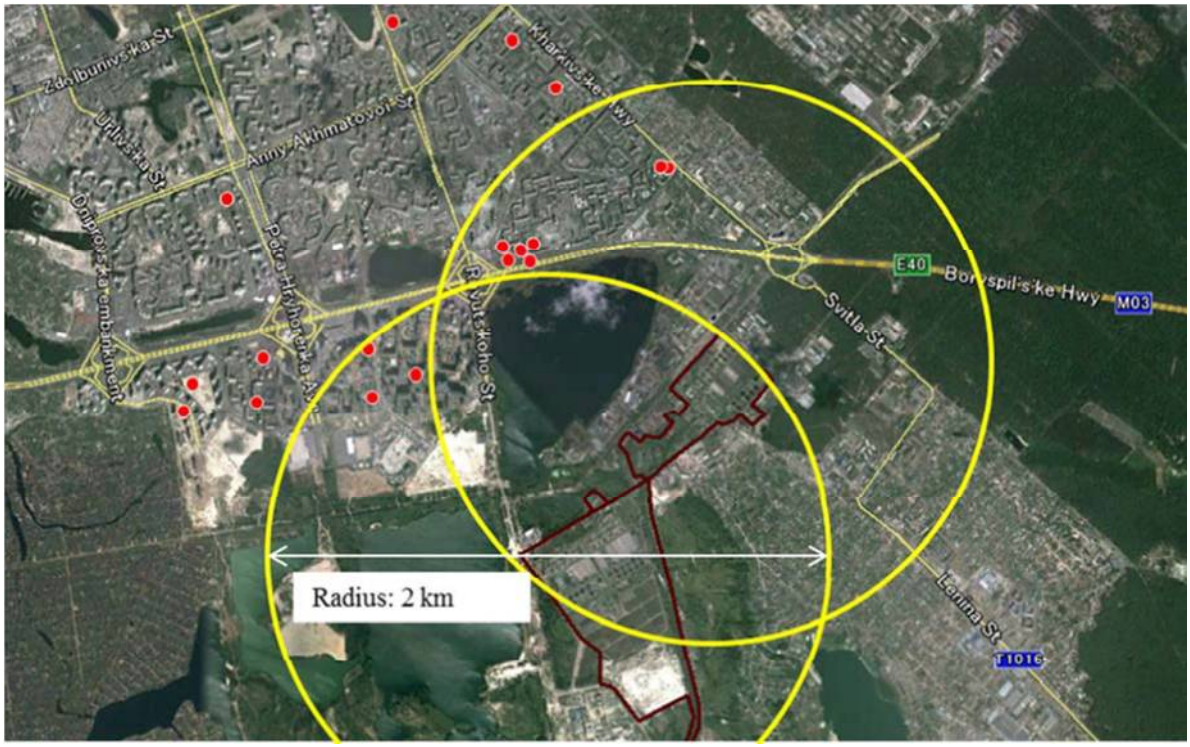
Note: Highlighted columns exceed the MPC.

Apart from general ambient air quality, KVK is obligated to monitor air quality of working environment.

7.1.5. Odor Problems of BAS

The odor is the cause of the main complaints against the BAS. In 2012, Kiev City State Administration received twenty-five complaints from the citizens. In 2013, twenty-one complaints related to odor were officially received during February to September 2013. The locations of the odor complaints are shown in Figure 7-2 below. The main sources of odor

from BAS are preliminary treatment (screen and sand treatment) and primary sedimentation tank. The odor complaints indicated by red dots scatter beyond the 2 km radius from the primary treatment tanks of BAS in northwest directions as far as 5 km from the BAS as shown in Figure 7-2.



Source: JICA Study Team

Figure 7-2 Locations of Odor Complaints

The structures of BAS are designed to be open and thus may become a cause of formation of unpleasant odors. Southeastern winds create the conditions for their spread within the residential areas.

7.1.6. Characteristics of Design Facility as Source of Ambient Air Pollution

The technological processes impacting ambient air are as follows:

Main production:

Receiving and treatment of domestic and industrial wastewater of Kyiv after preliminary treatment on the local treatment facilities according to the norms of input of influent into the sewage networks;

- Sending sewage sludge, after preliminary treatment (sedimentation or aerobic stabilization), for their dewatering and disposal in the incinerators;

- Incineration of excess active sludge (the emissions from the proposed incinerators are based on the assumption of the average designed volume of sludge with three out of four incinerators in operation);

Ancillary Activities:

- Production of heat;
- Production of air blowing flow;
- Laboratory-analytical works (chemical, physic-chemical, sanitary-microbiological, radiological research);
- Repair works (mechanical, electro technical, heating, plumbing, motor transport, construction);
- Emissions from motor transportation.

Emissions of pollutants calculated according to the mentioned processes, are calculated using specific indicators provided in “Manual of emission indicators (specific emissions) of pollutants into the ambient air by different industries"; "Methods of calculating the emissions of pollutants and greenhouse gases into the air by transportation" (order by State comstat of Ukraine№ 452 of 13.11.2008); the guide captioned "Indicators of emissions (specific emissions) of pollutants from processes of electro-, gas welding, overlaying, electro-, gas cutting and overlaying metals"; "Collection of methods on calculating emissions into the atmosphere, polluting substances by various industries".

Table 7-4 shows the calculation results of air pollutant emissions from all the sources in the BAS under the present operation and after reconstruction. The tabulations are based on the emission estimates for each facility as shown in Appendix B: Estimation of Pollutant Emissions by Sources For Ambient Air Concentration and then aggregated by substance as shown in Appendix C: Emission Estimation by Substance.

Table 7-4 List of Contaminating Substances Emitted Into Air

Contaminant	Code	$MPC_{max.\ 1time}$ mg/m^3	Hazard class	Current condition		After reconstruction	
				g/s	t/year	g/s	t/year
Iron oxide** (Fe)	123	0.400000	3	0.0280	0.0119	0.2580	0.2791
Cadmium oxide (in terms of cadmium)	133	0.003000	1	0	0	0.0016	0.0505
Manganese and its compounds (calculated into manganese dioxide) .	143	0.010000	3	0.0055	0.0010	0.0080	0.2246
Sodium hydroxide (caustic	150	0.010000	3	0.0000	0.0000	0.0006	0.0027

Contaminant	Code	$MPC_{max.\ 1time}$ mg/m^3	Hazard class	Current condition		After reconstruction	
				g/s	t/year	g/s	t/year
soda)							
Sodium carbonate (baking soda)	155	0.040000	4	0	0	0.0002	0.0051
Metallic mercury (Hg) and its compounds	183	0.003000	3	0	0	0.0015	0.0476
Lead and its compounds (in terms of lead (Lead and its non-organic compounds)	184	0.001000	3	0.0000	0.0000	0.0015	0.0476
Hexavalent chromium (in terms of chromium trioxide)	203	0.002000	4	0.0000	0.0000	0.0000	0.0000
Nitrogen dioxide	301	0.200000*	-	1.7331	12.3571	6.5106	192.0794
Nitric acid by $HNO_{3\ molecule}$ (hydrogen nitrate)	302	0.400000	3	0.0010	0.0007	0.0010	0.0007
Ammonia	303	0.200000	1	0.2041	6.3456	0.2212	6.9688
Nitric oxide	304	0.400000	2	0	0	0.0000	0.0005
Hydrogen chloride (chlorine hydride) by HCl molecule	316	0.200000	4	0.0009	0.0007	0.3025	9.5112
Sulfuric acid by H_2SO_4 molecule	322	0.300000	2	0.0002	0.0002	0.0132	0.1002
Crystalline Silicon dioxide (aerosil-175)	323	0.020000	4	0.0049	0.0051	0.0011	0.0048
Carbon Black	328	0.150000	-	0.2210	0.9590	0.315	0.9748
Sulfur dioxide	330	0.500000	4	1.8790	11.6530	1.5088	47.5708
Hydrogen Sulfide	333	0.008000	3	4.6395	45.0440	0.0637	2.6507
Carbon oxide	337	5.000000	-	1.1196	4.5412	1.8418	52.3867
Calcium fluoride gaseous compounds (hydrogen fluoride, 4-fluor-silicon)	342	0.020000	-	0.0001	0.0001	0.0307	0.9549
Highly soluble fluorides	343	0.030000	-	0.0017	0.0001	0.0020	0.0130
Non-soluble fluorides, non-organic	344	0.200000	-	0.0039	0.0002	0.0013	0.0066
Hexane	403	60.000000		0.0002	0.0002	0.0002	0.0002
Methane	410	50.000000		3639.3996	315.1857	3.5592	112.0777
Benzene	602	1.500000		0.0005	0.0004	0.0005	0.0004
Xylene	616	0.200000		0.0250	0.1238	0.0040	0.0328
Benz(a)pyrene	703	0.000010		0	0	0.0000	0.0001
Difluorochloromethane (Freon-22)	859	100.00000		0.0100	0.0500	0	0
isopropyl alcohol	1051	0.600000		0.0002	0.0002	0.0002	0.0002
Ethyl alcohol	1061	5.000000		0.0084	0.0060	0.0084	0.0060
Methylmercaptan	1715	0.000100		0.0270	0.8540	0.0013	0.0417
Ethyl mercaptan	1728	0.000030		0.0137	0.4065	0.0007	0.0207
Furan (furfural)	2424	0.010000	1	0	0	0.0000	0.000
Kerosene	2732	1.200000		0.0038	0.0100	0.0009	0.0100
Oil petroleum mineral (spindle, machine oil)	2735	0.050000		0.0262	0.8269	0.0026	0.0777
Synthetic detergent, "lotus" type	2744	0.030000		0	0	0.0005	0.0148
Solvent-naphtha	2754	0.200000		0	0	0.0151	0.0699
White spirit	2752	1.000000		0.0250	0.1238	0.1020	0.4719
Hydrocarbons marginal C12-C19 (solvent RC-265 and others)	2754	1.000000		0.0155	0.1838	0.0135	0.2938
Suspended solid, non-differentiated by content	2902			0	0	0.3016	9.5106
Polyacrylamide cationic ak-617	10161	0.250000		0.0162	0.0058	0	0
Titanium dioxide	10226	0.500000		0.0014	0.0001	0.0001	0.0000

Contaminant	Code	$MPC_{max.\ 1time}$ mg/m³	Hazard class	Current condition		After reconstruction	
				g/s	t/year	g/s	t/year
Emulsol	10265	0.050000		0	0	0.0001	0.0009
Wood dust	10293	0.100000		0.0704	0.0199	0.0703	0.0199
Abrasive metal dust	10431	0.300000		0.2660	0.0479	0.0260	0.0049

7.1.7. Forecast for Emission Mass in the zone of design activities

At operation of reconstructed Right Bank SPS in all its zone of impact on design facility maximum single emissions of pollutants (g/s, t/year) are forecasted

Characteristics of emission sources and certain emissions of pollutants are provided in Table 7-5.

Table 7-5 Estimated Emission of Right Bank Pumping Station

Substance code	Substance name	Current condition		After reconstruction	
		Emission capacity, (g/s)	Emission capacity, (t/year)	Emission capacity, (g/s)	Emission capacity, (t/year)
303	Ammonia	0.003935	1.187553	0.005648	0.178133
333	Hydrogen sulfide	0.077224	0.803539	0.0115836	0.365301
410	Methane	0.172069	5.427266	0.0258104	0.81409
1715	Methylmercaptan	0.002206	0.069577	0.000331	0.0104365
1728	Ethyl mercaptan	0.001103	0.0347956	0.0001655	0.0052193
	TOTAL	***0.256537***	***7.5227306***	***0.0435385***	***1.3731798***

7.1.8. Calculation of atmosphere pollution (CAP) by the object

(1) Methods and software for dispersion diagram calculation under CAP

Level of air pollution in the construction area is conditioned by the general city-wide emission sources. Industrial, energetic, transport and utility companies are located at a considerable distance from the designed object. Closely spaced is the road network. The dispersion model is “EOL”-software which is originally based on the model “ODN-86.” ODN-86 is developed in the Soviet Union (See Appendix F: OND -86).

Calculation of harmful atmosphere pollutant emission is provided and indicated in tabular form. Pollutant air dispersion diagrams have been assessed on estimated basis using the ODNN-86 method and approved “EOL”-software on topographic basis. Construction area is

covered by one estimation site. Pollution assessment (print-out from "EOL"-software) is provided on sketch-maps and in attachment in tabular form.

Measures on air condition normalization has been developed in accordance with the GOST 17.2.3.02-78, DSP 173-96, DSP 201-97 and other regulatory documents. Concentration values are rounded up to 0.01.

7.1.9. Impacts on Ambient Pollutants Concentrations

Figure 7-3. Location Diagram of Calculation Points (PTs) where the pollution level is measured: PT1 – Bazhana Ave., PT2 – Revutskoho St., and PT3 – Berezneva St.

Table 7-6 Results of disperse calculation (not considering background contamination)

Pollutant	$MPC_{max.1time}$	2 Berezneva st., PT3	Revutskogo st., PT2	Bazhana Ave., PT1	2 Berezneva st., PT3	Revutskogo st., PT2	Bazhana Ave., PT1
		Current condition			After reconstruction		
Nitrogen dioxide	0.200000	0.04	0.04	0.06	0.46	0.08	0.08
Ammonia	0.200000	0.03	0.02	0.02	0.08	0.03	0.03
Hydrogen sulfide	0.008000	4.32	4.41	4.2	0.25	0.13	0.09
Methylmercaptan	0.000100	4.41	3.32	3.5	0.21	0.15	0.12
Ethyl mercaptan	0.000030	8.34	7.15	4.25	0.34	0.26	0.20
CO	5.000000						
SO_2	0.500000	0.01	0.01	0.01	0.01	0.01	0.01
HCl	0.200000	0.03	0.02	0.02	0.04	0.03	0.02
Dust	0.400000	0.01	0.01	0.01	0.01	0.01	0.01

*NO_x (recalculated into NO_2)

Table 7-7 Results of dispersion calculation (considering background contamination)

Contaminating substance	Hazard	MPC in air of resident	Background concent	Calculation of maximum ground concentrations as a part of MPC

				Residential area	SPZ border	
				PT3 Berezneva St.	**PT2 Revutskoho St.**	**PT1 Bazhana Ave.**
Nitrogen Dioxide	3	0.2	0.92 (0.4**)	0.83	1.00	1.00
Hydrogen sulfide	2	0.008	0.31	0.58	0.40	0.43
Ammonium	4	0.2	0.10	0.19	0.10	0.10
Methyl mercaptan	2	0.0001	0.40	0.29	0.12	0.12
Ethyl mercaptan	-	0.00003	0.40	0.48	0.14	0.21
CO	4	5.0	0.58	0.59	0.59	0.59
SO_2	4	0.5	0.06	0.10	0.10	0.10
HCl	4	0.2	0.52	0.54	0.54	0.54
NO_2	3	0.2	0.37	0.38	0.38	0.38
Dust	2	0.3	0.19	0.21	0.21	0.21

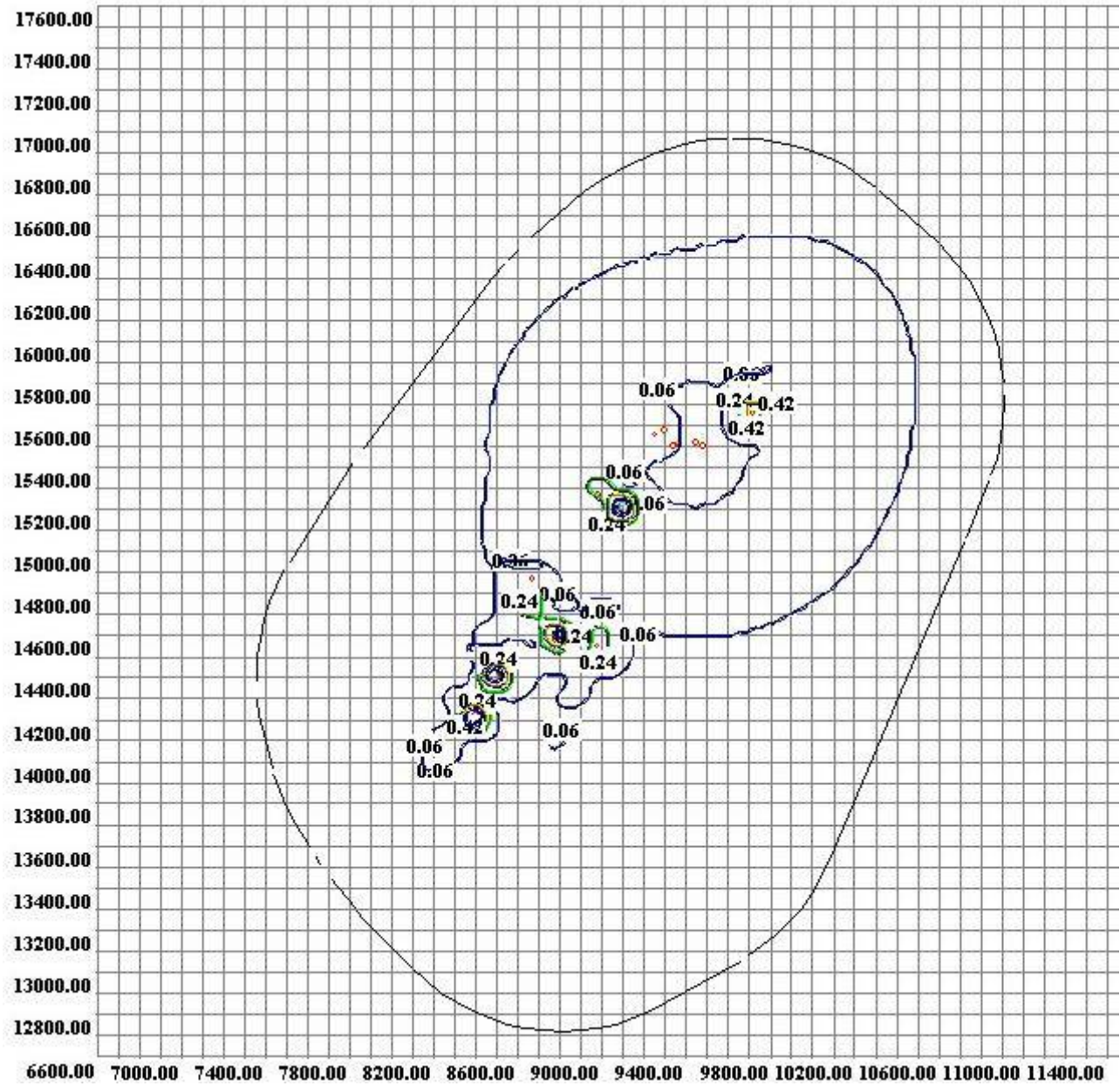
** The background concentration values for this territory has been assumed as 0,4 MPC in terms of Nitrogen Dioxide, with consideration of the fact that the current territory is located at a considerable distance from transportation and industrial enterprises and infrastructure. Regarding the other substances, the data of the Central Geophysical Observatory was used.

The analysis of calculations, provided considering the background contamination of ambient air, showed, that at all ingredients and possible summarizing of impact of polluting substances of ground concentration on border of the normative SPZ of BAS do not exceed the limits.

Diagram of pollutant dispersion on the surface layer by MPSC provided as per attachment do this volume in print-out of the “EOL”-software.

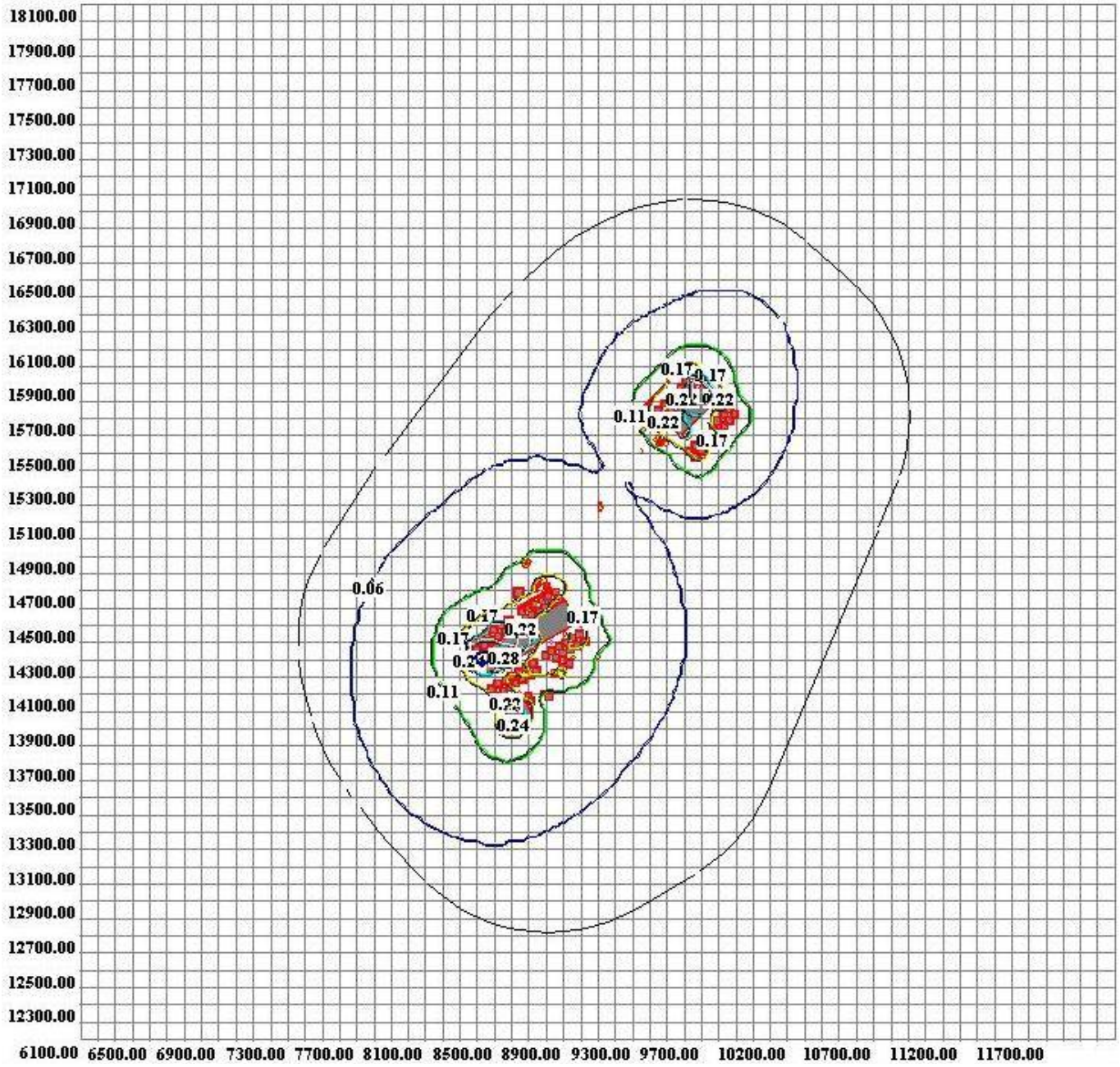
(1) **Existing Conditions**

Figure 7-4 Nitrogen Dioxide Atmospheric Concentration Dispersion (Present)



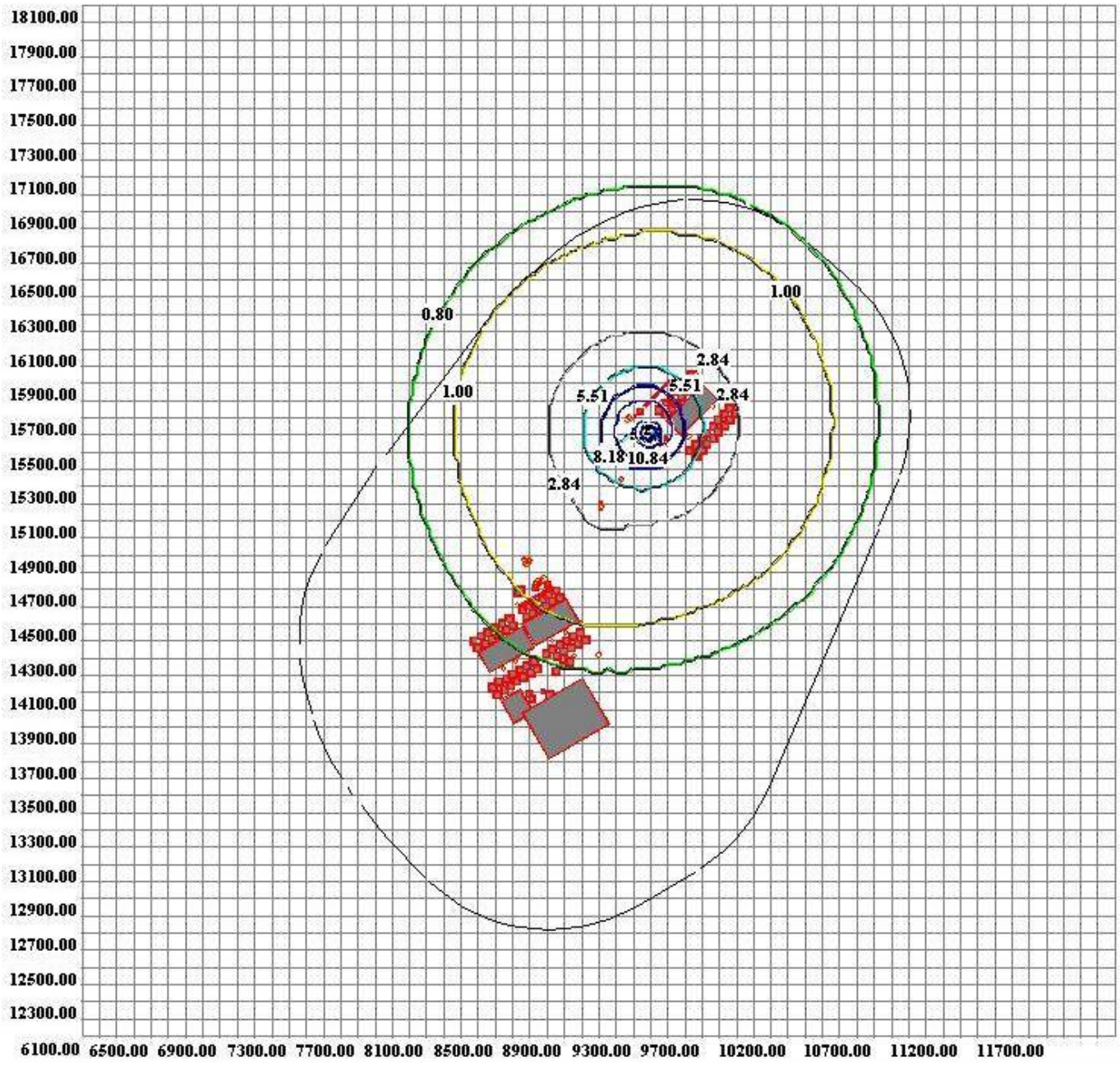
Note: NO_2 dispersion from the heating system, the figures on the graph indicate the ratio to the Maximum Permissible Concentration (=1 when the concentration is at MPC of 0.2 mg/m3). X and Y axes are meter distances.

Figure 7-5 Ammonium Atmospheric Concentration Dispersion (Present)



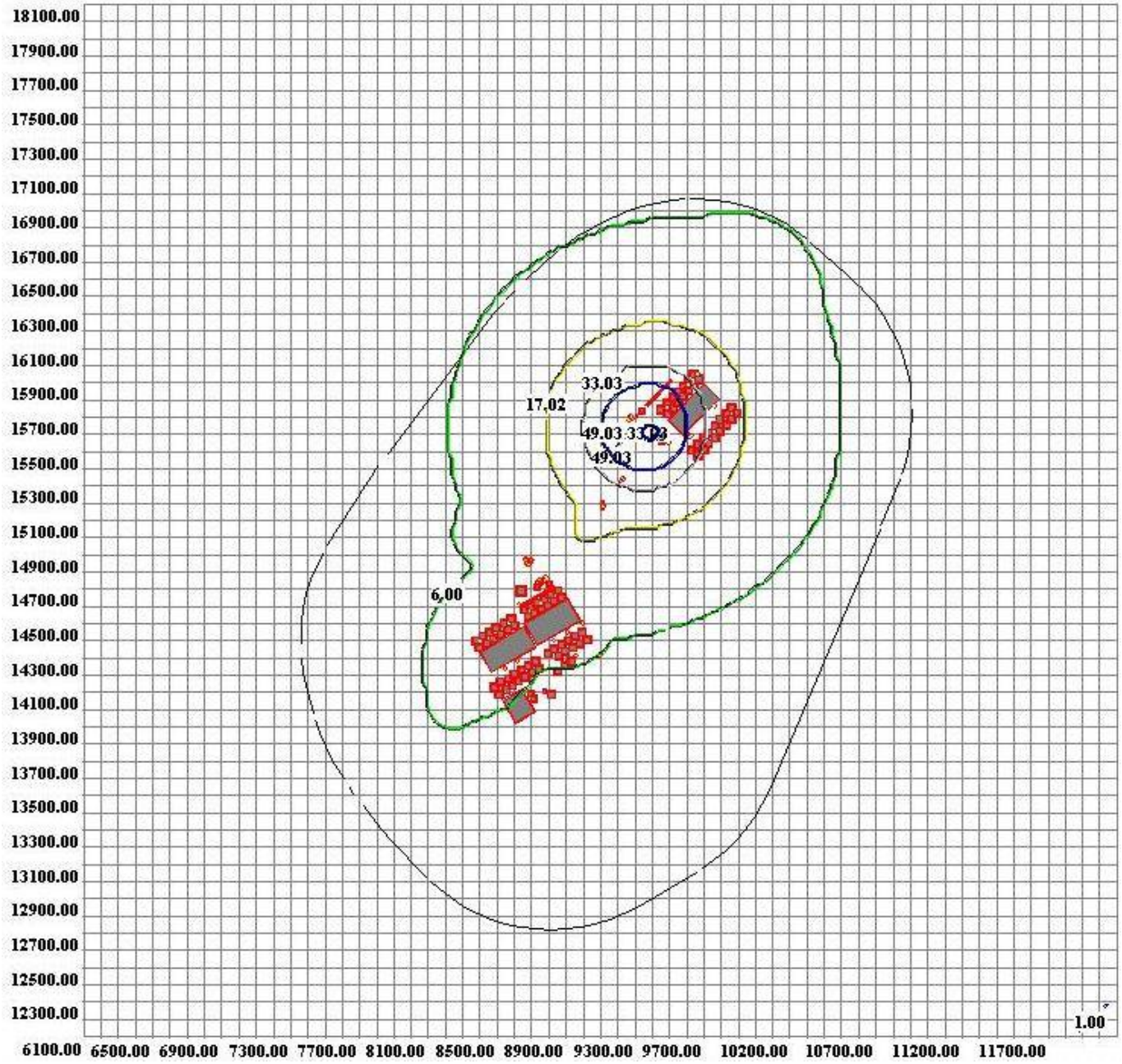
Note: NH_3 dispersion from the heating system, the figures on the graph indicate the ratio to the Maximum Permissible Concentration (=1 when the concentration is at MPC of 0.2 mg/m3). X and Y axes are meter distances.

Figure 7-6 Methane Atmospheric Concentration Dispersion (Present)



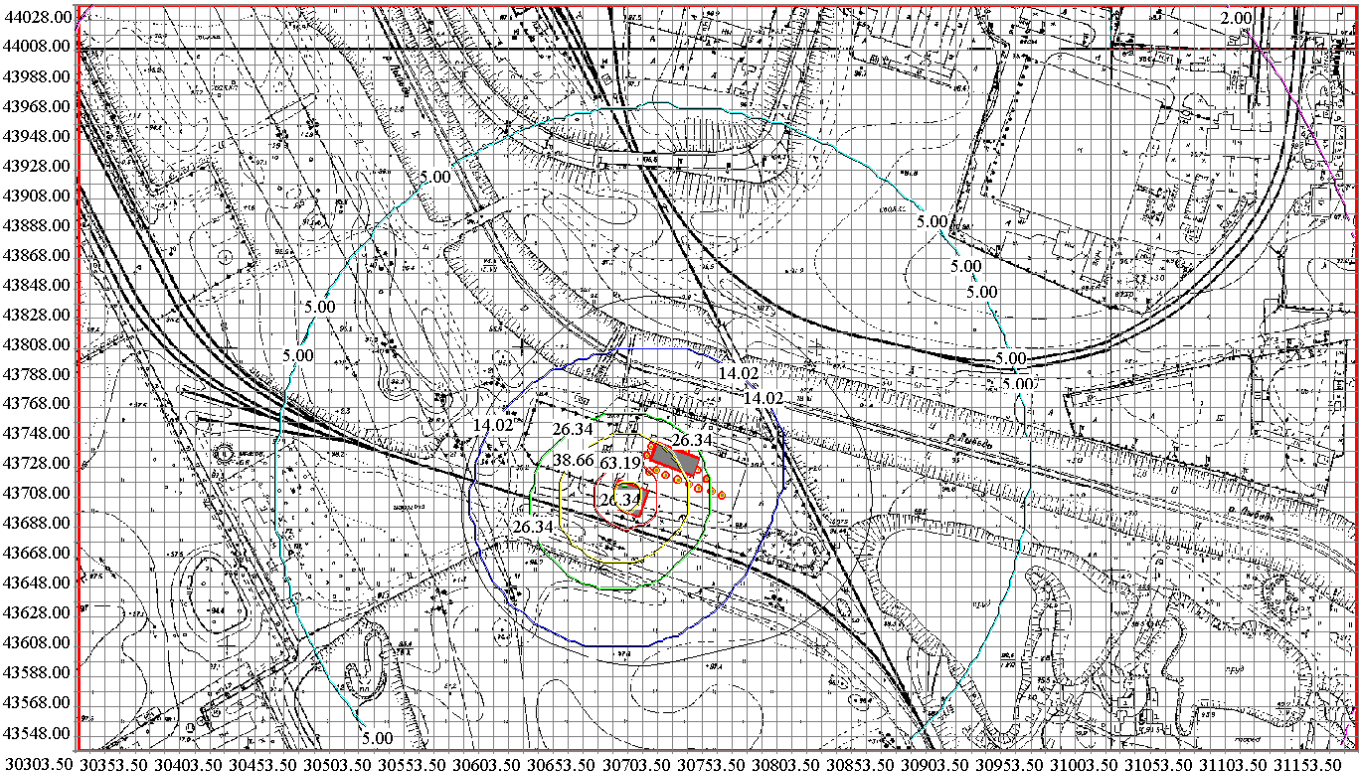
Note: CH_4 dispersion from the heating system, the figures on the graph indicate the ratio to the Maximum Permissible Concentration (=1 when the concentration is at MPC of 50 mg/m3). X and Y axes are meter distances.

Figure 7-7 Hydrogen Sulfide Atmospheric Concentration Dispersion (Present)



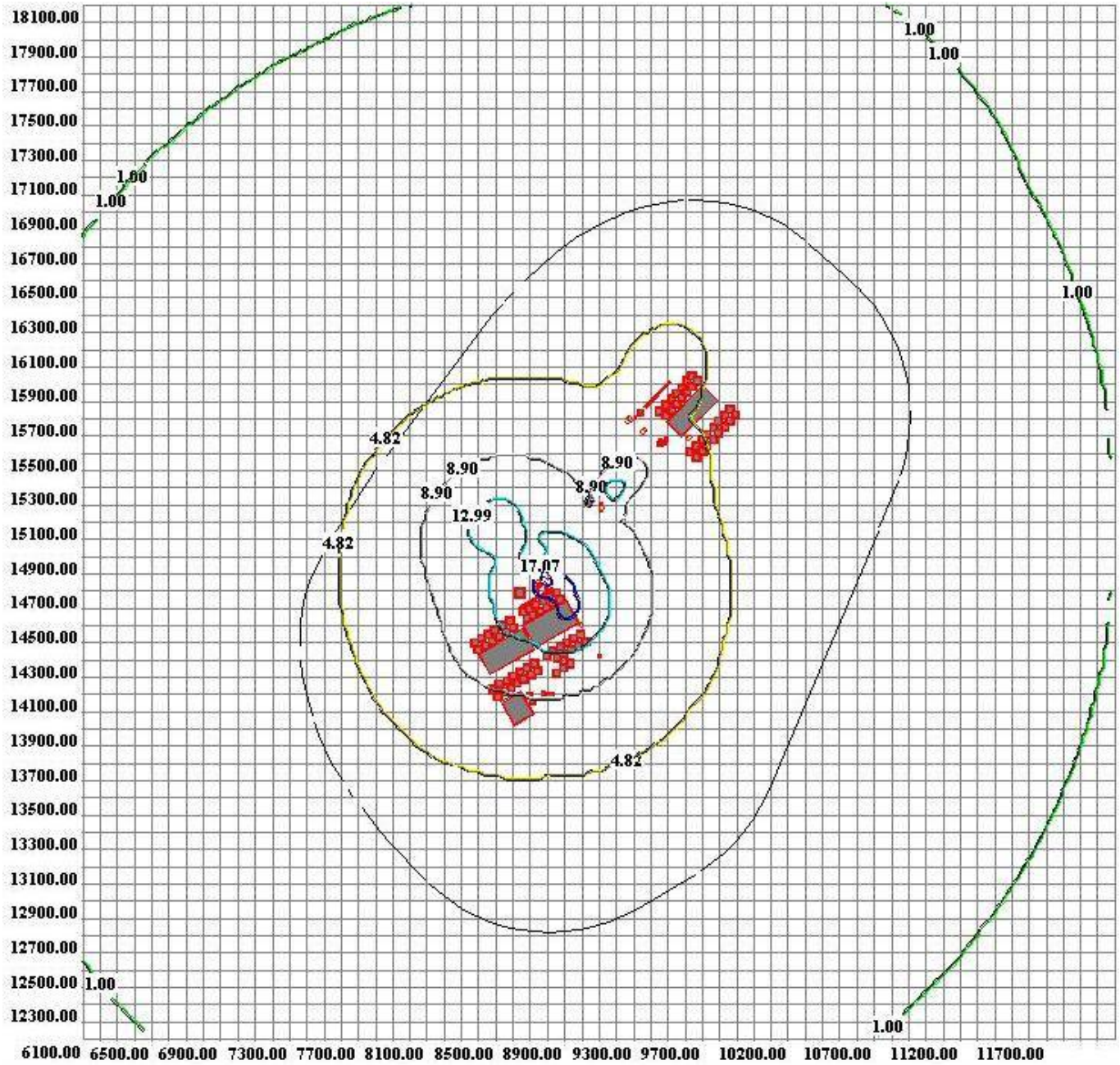
Note: H_2S dispersion from the heating system, the figures on the graph indicate the ratio to the Maximum Permissible Concentration (=1 when the concentration is at MPC of 0.08 mg/m3). X and Y axes are meter distances.

Figure 7-8 Hydrogen Sulfide from Pravoberezhna Pumping Station (Present)



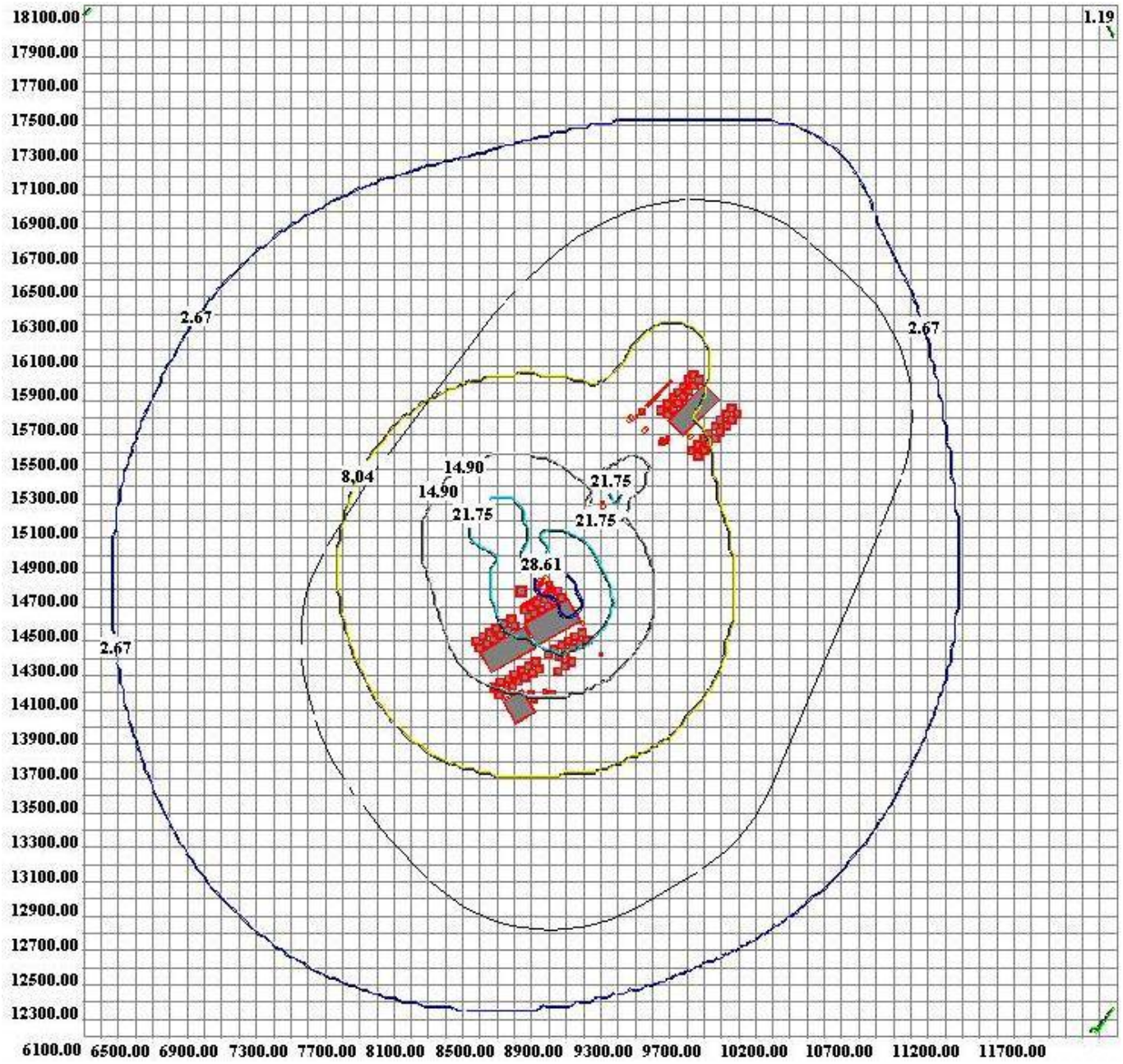
Note:H_2S dispersion from the heating system, the figures on the graph indicate the ratio to the Maximum Permissible Concentration (=1 when the concentration is at MPC of 50 mg/m3). X and Y axes are meter distances.

Figure 7-9 Mercaptan Atmospheric Concentration Dispersion (Present)



Note: CH_4S Methyl mercaptan dispersion from the heating system, the figures on the graph indicate the ratio to the Maximum Permissible Concentration (=1 when the concentration is at MPC of 0.001 mg/m3). X and Y axes are meter distances.

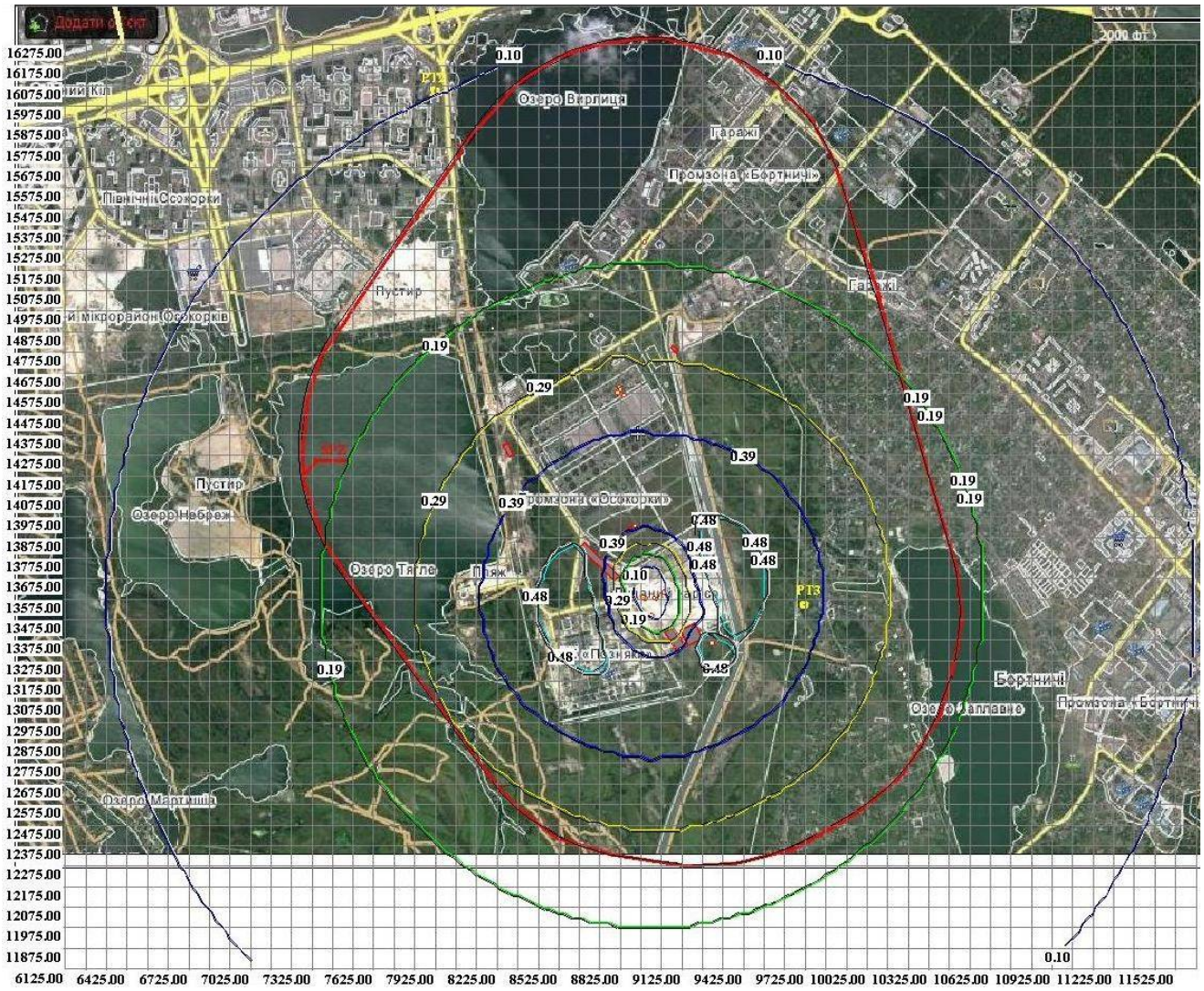
Figure 7-10 Ethyl Mercaptan Atmospheric Concentration Dispersion (Present)



Note: CH_6S Ethyl mercaptan dispersion from the heating system, the figures on the graph indicate the ratio to the Maximum Permissible Concentration (=1 when the concentration is at MPC of 0.00003 mg/m3). X and Y axes are meter distances.

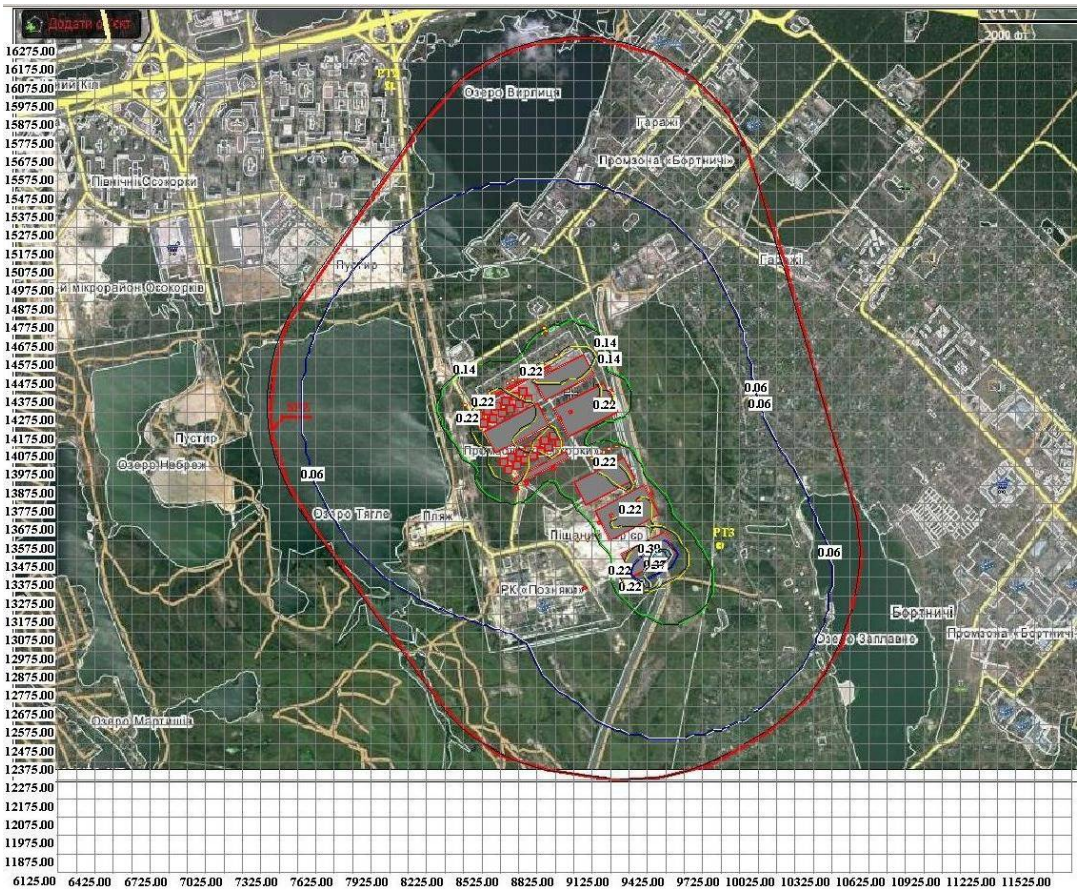
(2) **After Reconstruction Atmospheric Concentrations**

Figure 7-11 Nitrogen Dioxide Atmospheric Concentration Dispersion (ex-Project)



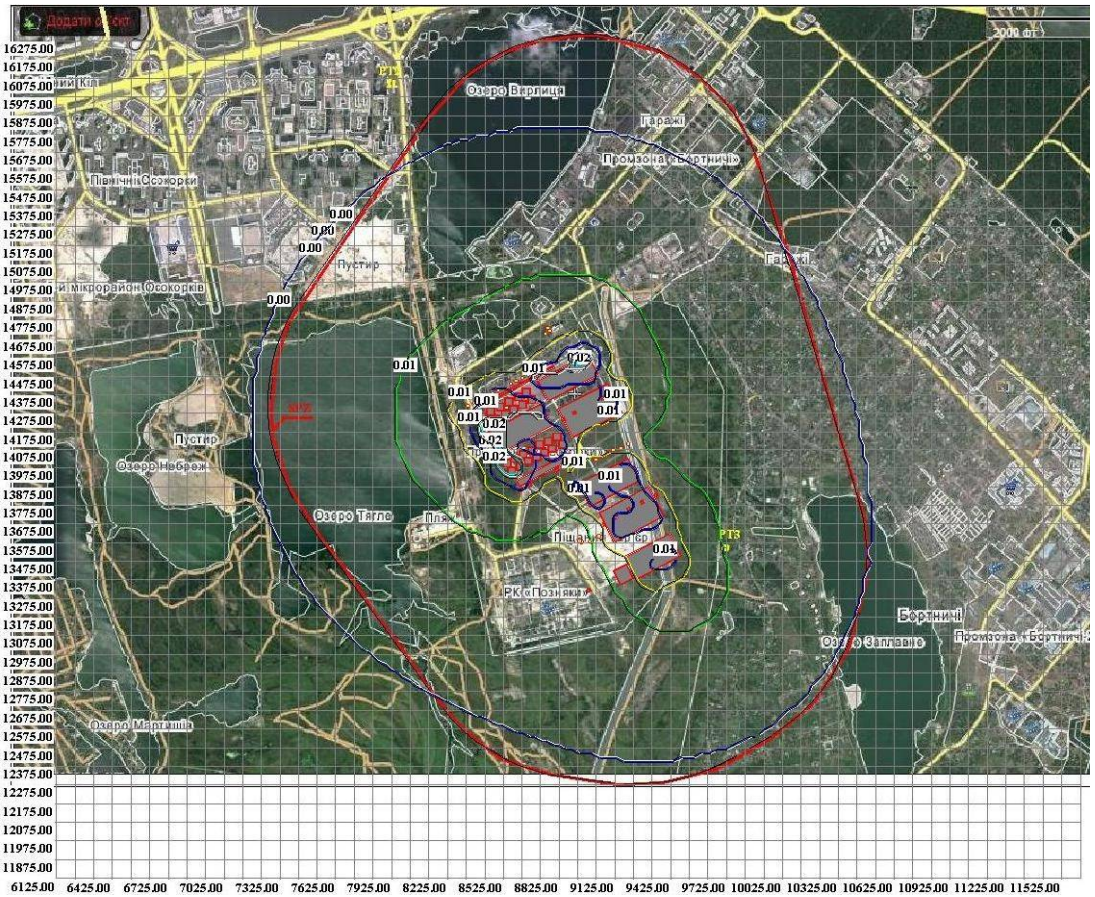
Note: NO_2 dispersion from the heating system, the figures on the graph indicate the ratio to the Maximum Permissible Concentration (=1 when the concentration is at MPC of 0.2 mg/m3). X and Y axes are meter distances.

Figure 7-12 Ammonium Atmospheric Concentration Dispersion (ex-Project)



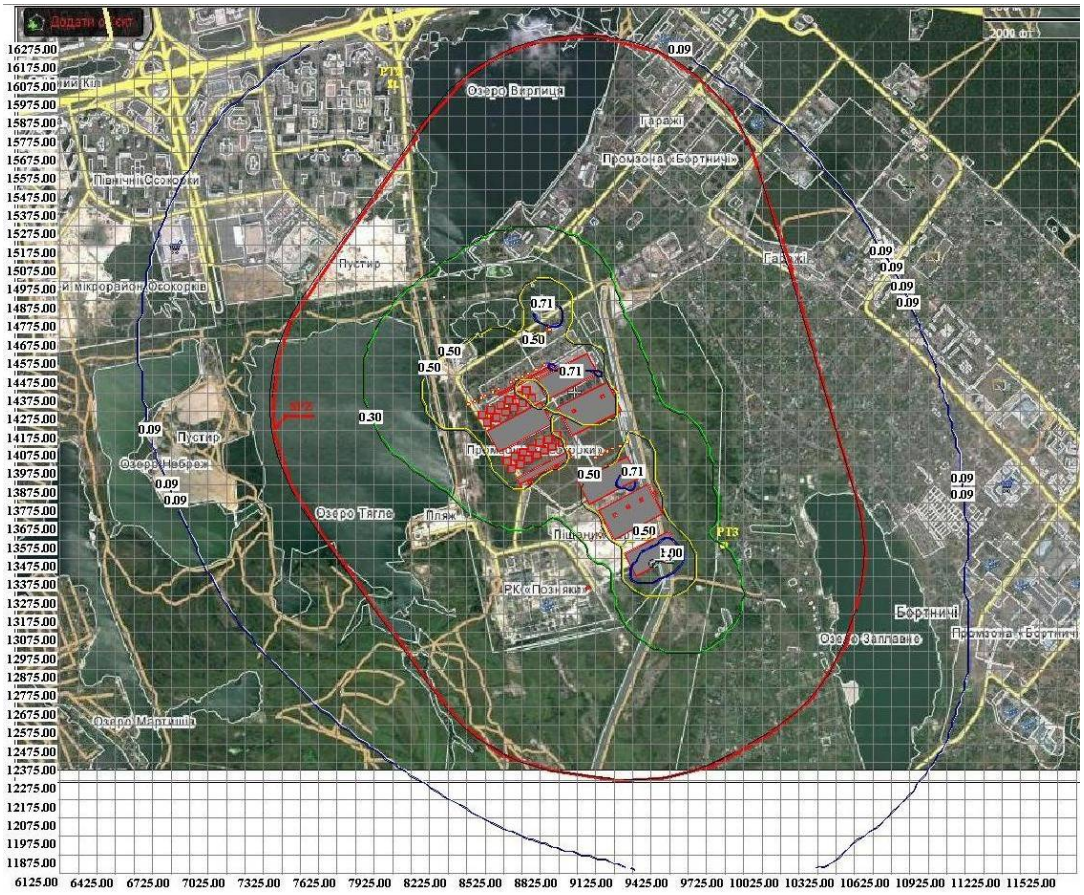
Note: NH_4 dispersion from the heating system, the figures on the graph indicate the ratio to the Maximum Permissible Concentration (=1 when the concentration is at MPC of 0.2 mg/m3). X and Y axes are meter distances.

Figure 7-13 Methane Atmospheric Concentration Dispersion (ex-Project)



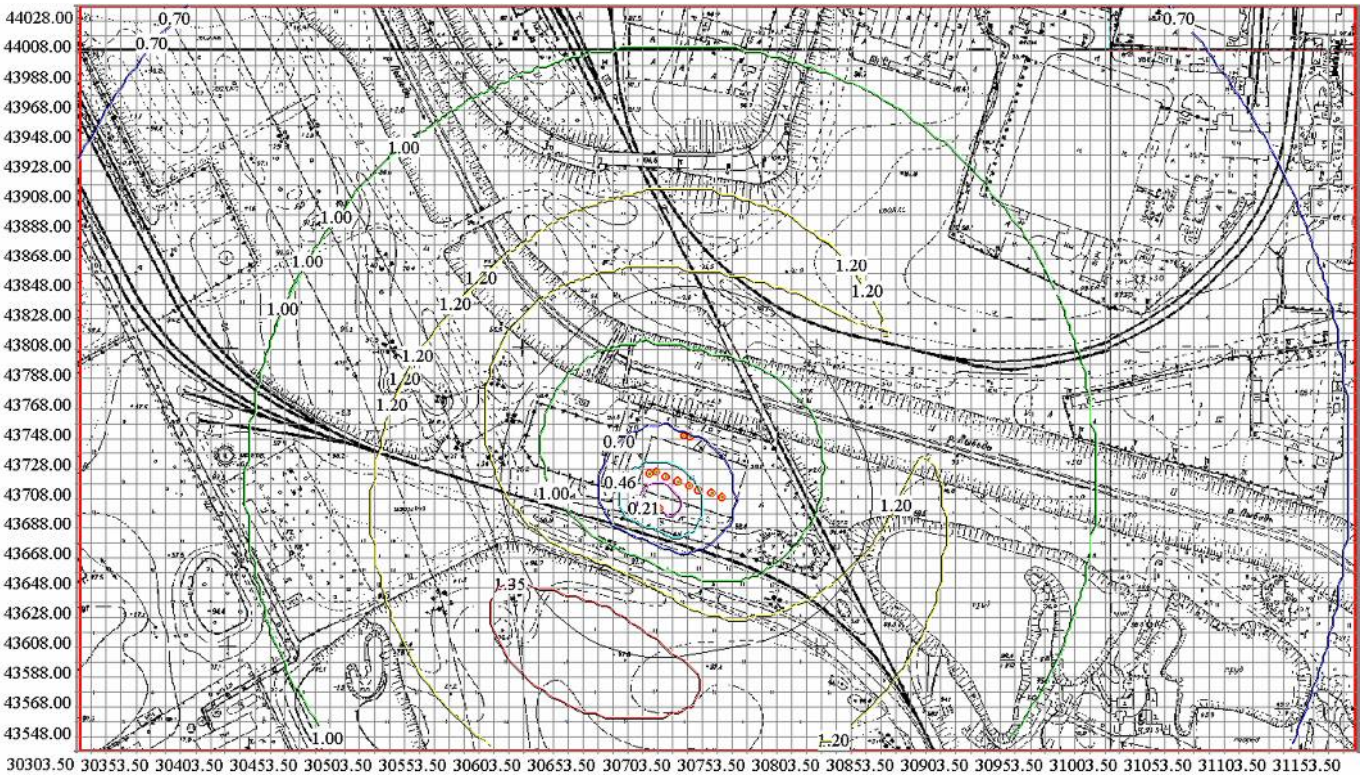
Note: CH_4 dispersion from the heating system, the figures on the graph indicate the ratio to the Maximum Permissible Concentration (=1 when the concentration is at MPC of 50 mg/m3). X and Y axes are meter distances.

Figure 7-14 Hydrogen Sulfide Atmospheric Concentration Dispersion (ex-Project)



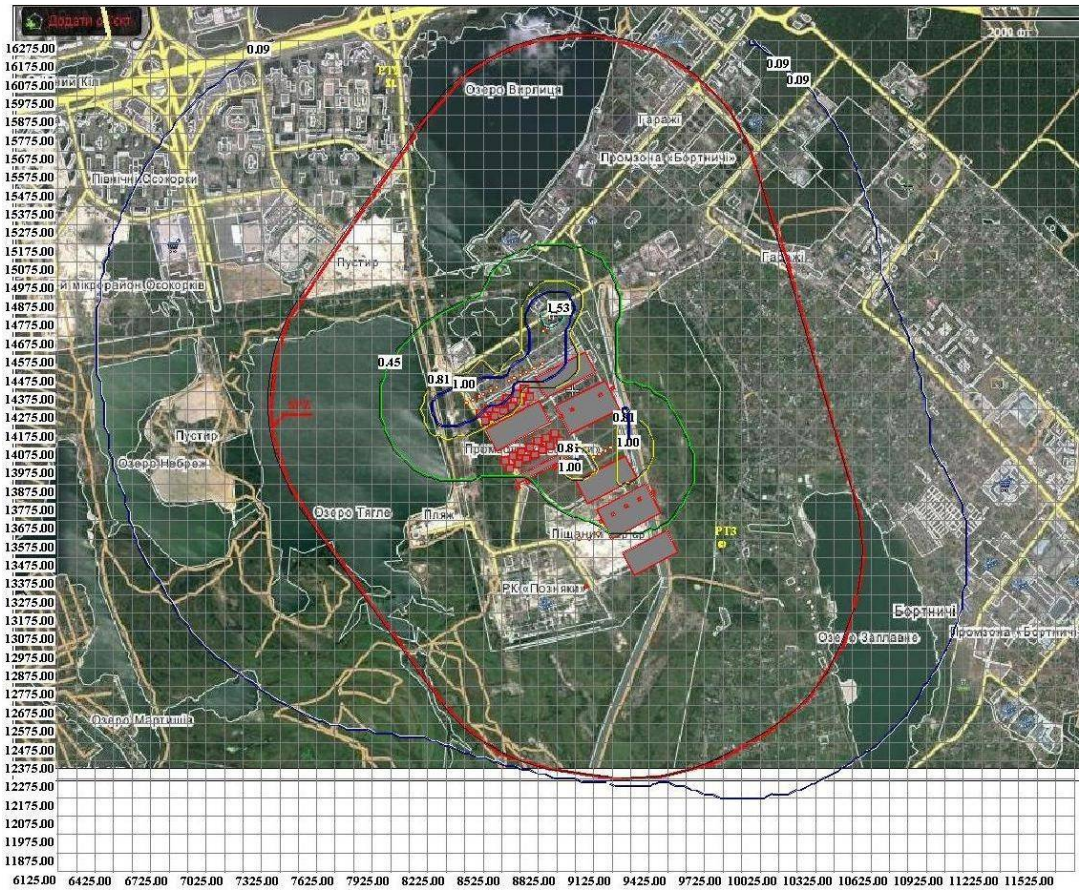
Note: H2S dispersion from the heating system, the figures on the graph indicate the ratio to the Maximum Permissible Concentration (=1 when the concentration is at MPC of 0.08 mg/m3). X and Y axes are meter distances.

Figure 7-15 Hydrogen Sulfide from Pravoberezhna Pumping Station (ex-Project)



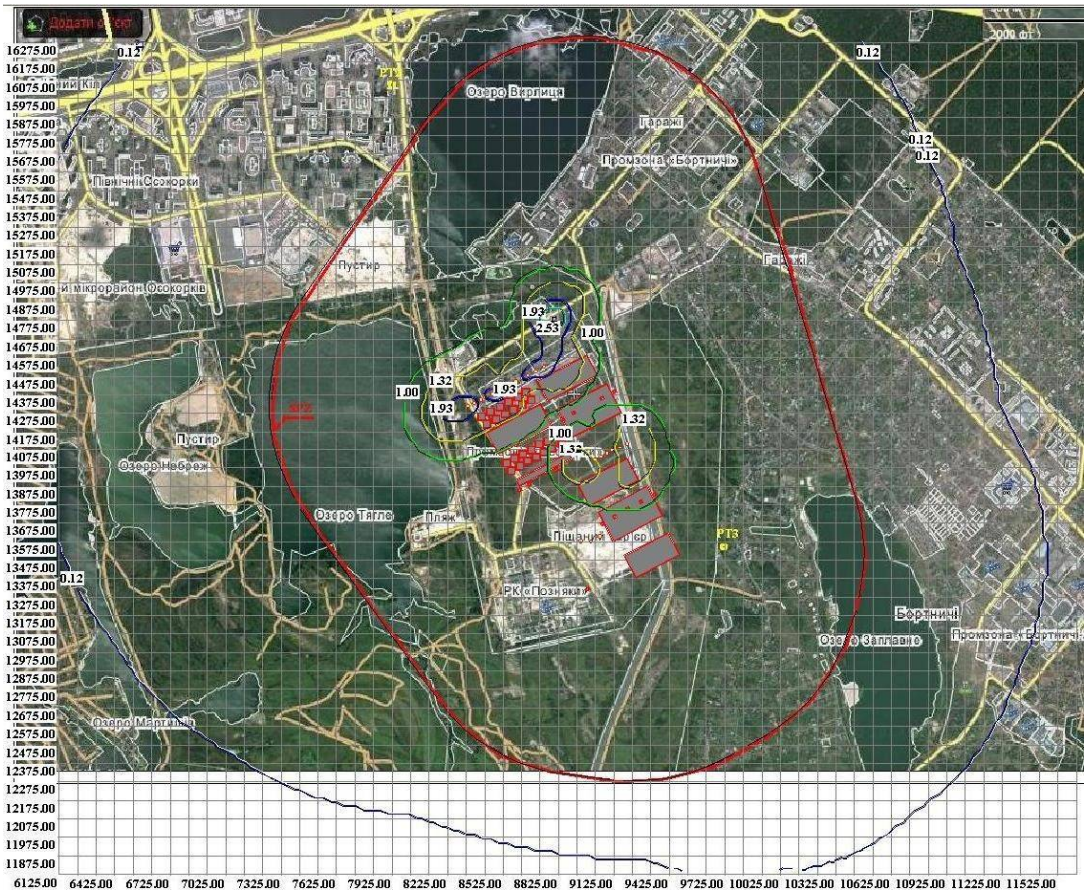
Note: H2S dispersion from the heating system, the figures on the graph indicate the ratio to the Maximum Permissible Concentration (=1 when the concentration is at MPC of 0.08 mg/m3). X and Y axes are meter distances.

Figure 7-16 Mercaptan Atmospheric Concentration Dispersion (ex-Project)



Note: **CH_4S Methyl mercaptan** dispersion from the heating system, the figures on the graph indicate the ratio to the Maximum Permissible Concentration (=1 when the concentration is at MPC of 0.001 mg/m3). X and Y axes are meter distances.

Figure 7-17 Ethyl Mercaptan Atmospheric Concentration Dispersion (ex-Project)



Note: **CH_6S Ethyl mercaptan** dispersion from the heating system, the figures on the graph indicate the ratio to the Maximum Permissible Concentration (=1 when the concentration is at MPC of 0.00003 mg/m3). X and Y axes are meter distances.

7.2. Aquatic environment

7.2.1. Environmental Standards

(1) Surface Water

The quality of water and water bodies is categorized as follows by Order of the Ministry of Health of

Ukraine On approval of the State sanitary rules and planning development of human settlements, No.

173, June 19, 1996 in Ukraine.

Category I – UD (utility and drinking: for centralized or decentralized drinking water and water for food businesses)

Category II – CL (cultural and living: for swimming, sports recreation, and water bodies within settlements)

Table 7-8 Water Quality of Surface Water in Ukraine

Category of water use	Category I - UD For centralized or non-centralized drinking water supply and water supply for food industries	Category II - CL For swimming, sports and recreation of population as well as residential areas
Suspended solids	Contents of suspended solids must not increase < 0.25 mg/l	Contents of suspended solids must not increase <0.75 mg/l
Floating component	On the surface of the reservoir, the floating matters, patches of mineral oils or other clusters of impurities should not be detected.	
Odor	Water must not take any unusual odors with intensity of more than 1 point	
	either directly or subsequent chlorination or other processing means	Directly
Color	20 cm transparency	10 cm transparency
Temperature	Summer temperature of water as the result of water flow must not increase more than 3 ^{o}C compared with average monthly temperature of the warmest month of the year for the last 10 years.	
pH	Must not exceed the limits of 6.5 - 8.5	
Mineral composition	Less than 1000 mg/l, including chlorides - 350 mg/l, sulfates - 500 mg/l	

DO	Must not be less than 4 mg/l in any season of the year, taken before 12 PM	
BOD	At 20 C, < 3 mg / l	At 20 C, < 6 mg / l
COD	< 15 mg / l	<30 mg / l
Pathogenic agents	Water should not contain pathogenic agents	
E-coliform	Not more than 10,000 per l	Not more than 5,000 per l
Coliphage (in plaque-formed units)	Not more than 100 per l	Not more than 100 per l
Viable helminthic eggs (Ascarididae, whipworms, Toxocara canis) hexacantha and viable cysts of pathogenic intestinal protozoa	Must not be contained in 1 l	
Chemical substances	Must not be contained in concentrations, exceeding MCL	

Source: Order of the Ministry of Health of Ukraine No. 173, June 19, 1996

The water of Dnipro River is used for swimming, sport and recreation activity, and water reservoirs within the territory of residential areas (Category II – CL (cultural and living)) at the 500 m downstream of the confluence of Dnipro River and channel.

The closest utility and drinking water-supply point is in the area of Ukraiinka-Trypillia-Khalepy region, where water intake of Bila Tserkva and industrial water intake facilities are located (Category I – UD (utility and drinking)). The control point of diffusing treated sewage water of Kiev City into waters of Dnipro River is located near the village of Ukraiinka.

The Kaniv Reservoir is located 60-70 km downstream of the discharge point of effluent. The Kaniv Reservoir is a water reservoir located on the Dnipro River in Ukraine, created in 1972 by the dams of the Kaniv Hydroelectric Station. It covers a total area of 675 km^2 within Cherkasy and Kiev Oblasts.

(2) Sewerage Treatment Effluent Standards

Table 7-9 shows the national standards for sewerage effluents.

Table 7-9 Sewerage Effluent Standards

Parameters (concentration)	Unit	Norms 2021
SS total	mg/l	15
BOD_5	mg/l	15
COD	mg/l	80
Nitrogen ammonium	mg/l	N/A
Nitrites	mg/l	3.3

Nitrates	mg/l	45
Total Phosphorus	mg/l	1
Dissolved oxygen	mg/l	4

7.2.2. Current Status on Aquatic Environment

The river water quality of Dnipro River at the confluence of the effluent is analyzed by KVK regularly (once / month from March to October). The quality is monitored at 10 locations: right bank, midst and left bank of the discharge point, 500 m upstream and 500 m downstream, and channel as shown in Figure 7-17.

Source: JICA Study Team

Figure 7-18 Monitoring Location of River Water Quality of Dnipro River

The results of monitoring of river water quality at 10 locations are shown in Table 7-10 below.

Table 7-10 Water Quality of Dnipro River and Channel as of October 2013

Sampling location	Water temperature	pH	SS mg/l	Chloride mg/l	BOD_5 mg/l	DO mg/l	COD mg/l	Phosphate mg/l	Grope of nitrogen mg/l			Bacteriological analysis	
									Ammonia nitrogen	Nitrite	Nitrate	the total microbial count	coli-index
500 m upstream of Dnipro													
Left bank	9	8.44	1.6	22.2	2.8	10.24	30.1	0.29	0.20	0.01	1.05	69	$24x10^2$
Center	9	8.43	3.0	20.8	2.0	10.56	32.0	0.29	0.20	0.01	1.28	122	$24x10^2$
Right bank	9	8.43	3.2	22.2	2.0	10.56	33.6	0.29	0.20	0.01	1.31	132	$62x10^2$
Discharge point													
Left bank	9	8.36	2.2	22.4	2.8	10.24	32.0	0.38	0.42	0.08	1.46	710	$24x10^3$
Center	10	8.31	2.4	25.5	2.0	10.08	34.0	0.43	0.87	0.13	1.69	1032	$62x10^3$
Right bank	10	8.32	2.8	25.7	3.2	9.92	35.2	0.46	1.03	0.16	1.86	1035	$62x10^3$
500 m downstream													
Left bank	10	8.33	2.4	25.9	3.2	9.92	32.0	0.40	0.65	0.11	1.93	780	$62x10^3$
Center	10	8.32	2.0	26.0	3.2	10.24	32.0	0.42	0.84	0.13	1.89	765	$62x10^3$
Right bank	9	8.38	3.8	25.7	2.8	10.24	34.0	0.36	0.44	0.07	1.80	583	$62x10^3$
Discharge channel													
	-	7.84	9.2	83.2	8.8	6.56	60.8	4.02	10.90	1.78	25.9	18300	$62x10^4$

Source: KVK

The water quality of channel and Dnipro River at the control point is stipulated by the documents for "Approval and Confirmation of MPD for Substances and Action Plans to Achieve MPD for Substances in Treated Return Water" issued by State Department of Environmental Protection in Kiev. The documents decide the permissible concentration and maximum permissible discharge (MPD) of the control points of main channel and Dnipro River. The approval is effective from 2 December 2011 till 2 December 2014.

Table 7-11 Results of Water Quality and MPD (maximum permissible discharge) from BAS

No.	Indicator	Actual		Approved	
		Actual concentration mg/l	Actual discharge g/hour	Approved permissible concentration mg/l	Approved MPD g/hour
Control Point #1 (main channel) – the point of complete mixing of biologically treated wastewater from blocks I, II and III of BAS (500 m downstream in the main channel from the discharge point)					
1	Ammonia nitrogen	8.45	300,610.1	8.90	667,500.0
2	BOD_5	7.40	263,256.2	15.00	1,125,000.0
3	Suspended solids	15.26	542,877.0	15.00	1,125,000.0
4	Total iron	0.28	9,961.0	0.33	24,750.0
5	Mineral content	553.00	19,673,063.5	600.00	45,000,000.0
6	Petroleum products	0.05	1,778.8	0.20	15,000,0
7	Nitrates (anion)	26.80	953,414.3	45.00	3,375,000.0
8	Nitrite (anion)	2.10	74,707.8	3.30	247,500.0
9	Synthetic surface active substances (anionic)	0.10	3,557.5	0.50	37,500,0
10	Sulfates (anion)	56.00	1,992,209.0	120.00	9,000,000.0
11	Phosphates (anion)	6.05	215,229.7	8.00	600,000.0
12	Chlorides (anion)	80.90	2,878,030.4	350.00	2,625,000.0
13	COD	68.30	2,429,783.4	80.00	6,000,000.0
Diffusing discharge – the surface area of the Kanivske reservoir at a distance of 8 m from the left bank, 0.5 m from the surface (shown in the Figure 7.7)					
1	Ammonia nitrogen	1.6	56,920.3	2.00	150,000.0
2	BOD_5	2.50	88,937.9	4.5	337,500.0
3	Suspended solids	8.2	291,716.3	10.0	750,000.0
4	Total iron	0.46	16,364.6	0.46	34,500.0
5	Mineral content	430.0	15,297,318.8	430.0	32,250,000.0
6	Petroleum products	0.2	7,115.0	0.20	15,000.0
7	Nitrites	5.27	187,481.1	5.27	395,250.0
8	Nitrates	0.67	23,835.5	0.67	50,250.0
9	Synthetic surface active substances (anionic)	0.1	3,557.5	0.10	7,500.0
10	Sulfates (anion)	48.2	1,714,722.0	50.0	3,750,000.0
11	Phosphates (anion)	1.6	56,920.3	1.6	120,000.0
12	Chlorides (anion)	46.9	1,668,475.0	50.0	3,750,000.0
13	COD	48.1	1,711,165.2	48.1	3,607,500.0

Source: Documents for Approval and Confirmation of MPD for Substances, and Action Plans to Achieve MPD for Substances in Treated Return Water

Groundwater was found at the depths between 2.7 and 4.1 meters, absolute heights of 92.96 to 93.65 meters by the drilling survey. The groundwater inflow is mainly done by infiltration of atmospheric precipitation, as well as due to losses from water supply networks and by hydraulic connection with water of the Dnipro River. Seasonal fluctuations of groundwater level are also possible within 1.0 m, the main raise of groundwater level is observed during spring period, and decrease in water level in summer and winter. BAS site is generally referred as non-impounded by waters of the main aquifer under constant limiting conditions. Groundwater resources are not used around the BAS. The water of the effluent channel is not used for any purpose.

7.2.3. Current Impact on Aquatic Environment

Table 7-12 shows water qualities of raw sewerage for the period of 2008 through 2012.

Table 7-12 Water Qualities of Raw Sewage :Yearly Averages Between 2008 and 2012

(mg/l)

Year	Block	SS	VSS	BOD_5	COD_{Cr}	Mineral	Sulfate	Chloride	NH_4-N	PO_4	PP[*1]	SSAS[*2]	Total Fe
2008	1	376	273	243	778	602	65.7	83.0	26.0	20.59	1.5	2.08	2.47
	2	282	209	214	674	581	66.5	77.6	25.1	16.86	1.5	2.28	2.24
	3	279	204	215	693	596	64.7	78.0	26.5	17.92	1.5	2.33	2.19
	Ave	312	229	224	715	593	65.6	79.5	25.9	18.46	1.5	2.23	2.30
2009	1	389	288	276	832	640	52.8	84.0	27.5	20.62	1.4	1.79	1.64
	2	315	240	228	658	581	44.0	71.5	26.6	17.76	1.3	2.17	1.46
	3	327	247	240	677	597	53.1	70.7	27.4	19.59	1.3	2.15	1.53
	Ave	344	258	248	722	606	50.0	75.4	27.2	19.32	1.3	2.15	1.54
2010	1	309	237	233	655	672	58.4	83.5	29.0	16.15	1.0	1.85	1.81
	2	301	229	215	610	607	57.6	76.2	28.9	17.81	1.1	2.00	1.73
	3	325	243	231	651	602	56.2	75.6	31.0	19.26	1.1	2.02	1.74
	Ave	312	237	226	639	627	57.4	78.4	29.6	17.74	1.1	1.96	1.76
2011	1	338	254	285	652	605	60.4	80.1	33.7	15.98	1.5	1.79	1.56
	2	347	259	287	651	607	60.6	80.0	33.6	17.64	1.5	1.91	1.58
	3	373	278	317	653	594	62.0	80.2	35.4	19.66	1.5	1.85	1.63
	Ave	353	264	296	651	602	61.0	80.1	34.2	17.76	1.5	1.84	1.59
2012	1	225	166	211	495	570	42.2	86.1	33.7	11.99	1.3	1.80	1.44
	2	396	294	298	659	606	45.7	86.6	34.9	20.09	1.6	1.67	1.85
	3	367	272	283	632	570	44.9	85.9	34.8	18.36	1.5	1.67	1.77
	Ave	329	244	264	595	582	44.3	86.2	34.5	16.81	1.5	1.71	1.69
Maximum		396	294	317	832	672	66.5	86.6	35.4	20.62	1.6	2.33	2.47
Minimum		225	166	211	495	570	42.2	70.7	25.1	11.99	1.0	1.67	1.44
Average		330	246	251	668	603	56.3	79.6	30.3	18.08	1.4	1.98	1.78

PP[*1]: Petroleum products

SSAS[*2]: Synthetic surface active substances (anionic)

Table 7-13 shows the yearly changes in the average water qualities of treated water in BAS between 2008 and 2012. The treated water qualities satisfy the effluent standards in all indicators, where specified, except for NH_4-N. The treated qualities are declining in general for most of the indicators including BOD_5, COD, NH_4-N, and PO_4, particularly for the last two indicators. Table 7-13, shows that there is some perceptible trend of increases in NH_4-N concentration in inflow. This may be due to decreases in water consumption and consequential thickening of pollutants. However, the main cause may be attributed to the loss of treatment capacities. As described in 3.1.2 "Rationale of Project", the remixing of the return sludge from the disposal sites have deteriorated the processing capacities of the BAS. Table 7-14 shows the monthly measurements of water qualities of treated water at BAS in 2013. As indicated in red fonts, there are a large number of incidents where the measurements exceed the regulation limits especially in ammonium and nitrites and few in phosphates. These incidences indicate the current state of deteriorated treatment capacity.

Table 7-13 Water Qualities of Treated Water Yearly Averages Between 2008 and 2012 (mg/l)

Year	Block	SS	BOD_5	COD_{Cr}	Mineral	Sulfate	Chloride	NH_4-N	PO_4	PP[*1]	S.Surfac[*2]	Total Fe	DO
2008	1	12.0	5.0	60.7	547	59.0	78.0	7.5	2.4	0.05	0.07	0.37	3.92
	2	14.6	5.3	66.4	528	59.2	74.2	6.5	2.4	0.05	0.07	0.42	4.79
	3	12.8	4.2	59.1	537	57.2	72.9	4.9	3.4	0.05	0.06	0.37	4.95
	Ave	13.1	4.8	62.1	537	58.5	75.0	6.3	2.7	0.05	0.07	0.39	4.55
2009	1	10.2	6.6	56.7	543	49.6	75.8	5.7	2.1	0.05	0.08	0.32	4.50
	2	17.3	6.4	63.9	541	52.1	66.1	6.3	3.7	0.05	0.08	0.35	5.85
	3	13.0	4.9	57.7	533	54.3	66.2	6.1	4.9	0.05	0.08	0.33	5.76
	Ave	13.5	6.0	59.4	539	52.0	69.4	6.0	3.6	0.05	0.08	0.33	5.37
2010	1	11.0	5.3	65.8	583	54.4	79.4	5.7	2.1	0.04	0.08	0.31	4.73
	2	14.7	6.3	71.4	537	55.0	72.4	7.1	3.3	0.04	0.07	0.31	5.91
	3	15.4	6.3	71.1	530	56.9	72.8	5.9	4.2	0.04	0.07	0.32	5.50
	Ave	13.7	6.0	69.4	550	55.4	75.0	6.2	3.2	0.04	0.07	0.31	5.38
2011	1	9.9	5.5	61.5	549	56.0	85.5	4.0	3.4	0.06	0.11	0.24	4.82

	2	16.7	8.2	67.5	545	57.0	80.1	9.4	6.0	0.05	0.12	0.28	5.42
	3	16.8	8.8	66.8	556	58.0	79.4	8.0	6.5	0.05	0.13	0.28	5.54
	Ave	14.5	7.5	65.3	550	57.0	81.7	7.1	5.3	0.05	0.12	0.27	5.27
2012	1	12.1	6.7	82.8	535	51.0	81.6	5.4	2.4	0.05	0.10	0.31	5.23
	2	16.0	7.2	71.9	554	58.5	83.7	8.8	5.2	0.05	0.10	0.34	5.94
	3	16.7	7.1	67.3	521	53.6	83.1	5.8	6.0	0.05	0.09	0.33	5.68
	Ave	14.5	7.0	67.3	537	57.7	82.8	6.7	4.5	0.05	0.10	0.33	5.62
Maximum		17.3	8.8	71.9	583	61.0	85.5	9.4	6.5	0.06	0.13	0.42	5.94
Minimum		9.9	4.2	62.8	521	49.6	66.1	4.0	2.1	0.04	0.06	0.24	3.92
Average		14.0	6.3	67.3	543	59.2	76.8	6.5	3.9	0.05	0.09	0.33	5.24

*1: Petroleum products

*2: Synthetic surfactants (anionic)

Source: KVK

Table 7-14 Water Quality of Treated Water Monthly Measurements in 2013

Month	Chlorides mg/L	Nitrogen group, mg/dm^3			Phosphates, mg/L	Sulfates, mg/L	Iron, mg/L	Oxidation potential, mg/L	BOD_5 In natural water
		Ammonia nitrogen	Nitrites	Nitrates					
Block1									
January	102.6	3.86	4.68	38.4	1.69	53.3	0.27	19.1	6.8
February	91.8	9.89	5.54	25.9	0.38	70.6	0.26	19.9	7.0
March	79.6	4.28	11.26	22.9	0.19	57.3	0.28	24.0	7.2
April	80.7	4.24	13.50	24.0	0.11	78.8	0.31	23.9	7.5
May	74.3	9.85	7.26	22.2	0.13	79.4	0.30	21.0	4.8
June	73.2	4.89	6.51	16.3	0.39	81.0	0.25	20.2	7.2
July	79.8	5.98	6.49	23.2	0.35	31.7	0.28	22.4	10.6
August	83.9	2.77	4.36	40.6	1.16			16.5	7.4
September	82.7	1.60	0.92	37.2	2.34			14.4	5.2
October	84.5	8.31	2.45	32.7	1.07			14.1	5.8
November	86.3	4.32	1.97	39.0	0.37			18.4	8.0
December	90.3	5.03	6.83	38.4	0.22			19.3	8.6
Average	*84.1*	*5.42*	*5.98*	*30.1*	*0.70*	*64.6*	*0.28*	*19.4*	*7.2*
Block2									
January	101.2	11.21	2.01	30.6	2.33	64.6	0.31	21.2	8.6
February	93.0	7.11	2.93	31.5	2.79	53.7	0.32	20.3	8.4
March	81.8	8.91	5.58	21.8	2.36	51.8	0.30	19.9	8.6
April	83.7	5	7.10	25.3	3.56	69.9	0.32	16.8	8.6
May	73.9	11.34	3.91	25.2	4.51	81.9	0.29	20.7	6.8
June	71.3	12.53	1.86	1	7.90		0.35	25.9	9.3
July	78.0	12.21	4.40	6	2.87	78.0	0.33	18.4	8.2
August	88.1	12.39	3.39	9	5.90			14.9	7.5
September	85.9	11.12	1.51	18.9	3.75			16.0	6.4
October	89.0	10.29	1.33	20.6	7.15			17.9	6.0
November	88.0	8.32	1.94	30.8	4.69			13.1	7.9
December	92.5	7.92	3.66	33.9	7.03			18.3	9.2

Average	*85.5*	*9.92*	*3.30*	*21.3*	*4.57*	*66.7*	*0.32*	*18.6*	*8.0*
Block3									
January	98.9	7.85	1.7	31.1	4.19	67.1	0.36	23.7	10.6
February	91.0	5.03	1.8	37.5	4.44	69.5	0.27	18.9	7.4
March	81.3	4.14	2.77	34.6	4.43	60.5	0.30	21.3	9.6
April	84.1	4.49	2.89	31.4	5.18	78.2	0.32	14.7	7.8
May	72.8	9.78	2.09	25.9	5.49	85.8	0.27	20.8	7.6
June	71.2	8.599	2.12	3	3.81		0.35	24.9	9.9
July	78.5	9.32	1.92	5	4.23	57.2	0.32	18.3	8.6
August	87.5	11.27	1.88	7	5.42			15.4	7.2
September	87.5	12.47	0.98	12.8	3.66			14.8	4.5
October	90.6	10.28	1.04	21.2	8.03			15.0	5.4
November	88.5	8.91	1.38	27.6	7.37			13.9	8.7
December	92.3	6.92	1.22	34.4	8.59			14.9	5.6
Average	*85.4*	*8.25*	*1.82*	*22.8*	*5.40*	*69.7*	*0.31*	*18.1*	*7.7*
Station	*85.0*	*7.86*	*3.70*	*24.7*	*3.56*	*67.0*	*0.30*	*18.7*	*7.6*
Maximum Permissible Discharge	*350.0*	*8.90*	*3.30*	*45.0*	*8.00*	*120.0*	*0.33*	-	*15.0*

7.2.4. Sewage treatment facilities

The future plant will be, as well as the current one, composed of 3 independent technological lines of water treatment - Block 1, Block 2 and Block 3. the existing Block 3 will be maintained and enhanced, and Block 1 and Block 2 will be completely rebuilt.

Calculated distribution of expenditure between the three treatment blocks is based on the performance of the existing Block 3. Modeling process of biological treatment of the existing unit (by volume) and calculated expenditures that can be handled by compliance with the new requirements for the quality of treated wastewater to the extent of existing aero tanks Block 3. Also, the required additional capacity for the lighting of Block 3 is calculated.

The project solutions for Blocks 1 and 2 are developed for providing the insurance of compliance with the new requirements for the quality of treated wastewater to WWTP as a whole, taking into account the required nominal capacity of WWTP and allowable expenditures through Block 3 after reconstruction and expansion.

The project solution was developed with the expectation of maximum reliability of the process at any time. The facilities are able to function and provide the required quality of treatment, while individual machines or units are set out of operation, and the project provides backup of all stages of each process.

The additional load is evenly distributed between Block 1 and Block 2. Allowable expenditures and load that can be taken by each of the blocks, are defined based on their capacity for wastewater treatment.

As a result, the value of expenditures and loads that may come to each block of treatment are obtained.

7.2.5. Project Load

The load must be distributed in proportion to the expenditures of each unit.

Table 7-15 Distribution of design load between treatment blocks (nominal load)

Parameters	Meas. units	Block 1	Bock 2	Block 3	Total
COD	kg/day	323 270	323 270	234 748	881 289
BOD_5	kg/day	117 610	117 610	85 405	320 625
SS total	kg/day	152 830	152 830	110 980	416 641
SS volatile	kg/day	94 857	94 857	68 882	258 597
Total nitrogen	kg/day	21 572	21 572	15 665	58 810
NH_4N	kg/day	14 088	14 088	10 230	38 406
Total Phosphorus	kg/day	4 843	4 843	3 517	13 203
SS floating	kg/day	80 818	80 818	58 687	220 322

The following is a general description of technological processes that will ensure compliance with the new requirements for quality of treatment for the period until 2021.
the following technologies were selected for this object, providing the following benefits:

• use of lamella primary sedimentation tanks, which vary by compactness and meet the conditions of minimization;

• biological treatment with active sludge – a traditional technology that is widely used and validated with rich experience of practical application;

• ultraviolet irradiation provides effective decontamination;

• advanced treatment will remove the remaining contamination for full compliance with the stringent requirements for water quality.

7.2.6. Future Effluent Quality

Table 7-16 shows the parameters of quality of treated wastewater that must be provided at the output of each of the treatment unit and, consequently, the production of plants (accepted under the tender documentation) and meet the requirements of the EU Directive of 2006 on water bodies used for bathing.

Table 7-16 Planned Quality of Treated Wastewater

Parameters (concentration)	Unit	Norms 2021
SS total	mg/l	15
BOD_5	mg/l	15
COD	mg/l	80
Total nitrogen	mg/l	10
Nitrogen ammonium	mg/l	N/A
Nitrites	mg/l	3.3
Nitrates	mg/l	45
Total Phosphorus	mg/l	1
Dissolved oxygen	mg/l	4

In 2021 the requirements provided in Table 7-16 above must be performed at nominal terms of load on water treatment facilities.

In addition, in connection with the use of UV disinfection requirements, the quality of treated wastewater must also meet the requirements of the EU Directive of 2006 on water bodies used for swimming. In the mentioned Directive set are maximum permissible values:

Table 7-17 Requirements of Water Quality After UV Disinfection

Parameter	meas. unit	Maximum permissible number
Enterococcus	unit. /100ml.	400
E. coli	unit. /100ml.	1000

According to the current standards, Kanivsky reservoir area on 500.0m below the discharge of treated municipal wastewater refers to cultural and community (II cat. - gp) water use (swimming, sport and recreation population, as well as reservoir within settlements). Thenearest centralized economic and drinking water supply is in Ukrainka-Trypillia-Khalepy region, where the water intake of the town of Bila Tserkva and industrial water intakes is located. A control point (CP) of mixing the treated wastewater of Kyiv with water in Dnipro, accepted is point at the distance of 21.0 km from the issue at Ukrainka, located 55.0 km from Kiev hydroelectric station dam. At the control point of BAS standards of economic and drinking water (1 cat. - gp).

According to the calculations by SNiP_2.04.03-85, the Guide to SNiP_1.02.01-85; software tool «SBROS» implementing «Methods of calculation of maximum permissible discharge (MPD) of substances into water bodies with sewage waters" (VNYYVO State Commission of Nature Protection of USSR, Kharkov, 1990); "Methodology for calculating the maximum permissible discharge (MPD) of substances in water bodies of return waters"

(UkrNTsOV, Ministry of Environmental Protection of Ukraine, 1993) the rain water sewage of Kyiv is dispersed between 1:60 and 1:200, depending on the minimal water consumption of 95% ensuring in the discharge point, flow velocity, discharge point, number of discharges, coefficients of non-conservedness of substances and background contamination, .

During the design, the most stringent (conservative) coefficients of contamination K. dil. (dilution factor) : on the suspended solids - 20; for other pollutants - 40 are used. the adoption of conservative values K. dil. guarantees reliability of estimates of environmental impact and environmental safety.

Concentrations of pollutants in the effluent from the equipment of BAS after the release into Dnipro considering dilution (P) in comparison with average background of water pollution of the Desna, where: K. dilution - coefficient (conservative); MPD - rain water; MPD for fishing economic purpose.

Table 7-18 Water Quality After Dilution in Dnipro

Parameters	Norms 2021	K. dil	After dilution	Dnipro		
				Background av.	MPD	Accepted conc.
SS total	15	20	0.75	7.2	25.0	7.75
BOD_5	15	40	0.375	1.2	3.0	1.575
COD	80	40	2	33.7	62.5	35.7
Total nitrogen	10	40	0.25	?		
Nitrogen ammonium	N/A	40		0.57	0.5	?
Nitrites	3.3	40	0.08	0.03	?	0.11
Nitrates	45	40	1.125	2.7	?	3.825

The concentration of pollutants in wastewater treatment facilities of BAS after dilution in the reservoir does not exceed standards for facilities for fishing economy at considering average background contamination of Dnipro.

7.2.7. Parking Lot and Car Wash Wastewater Treatment

The Project documentation (Volume 5) provides the station of monitoring of quality of treated wastewater. Surface effluent from unpaved areas through the system of rain water basins allocated are local treatment facilities of gravity type BMK "EKMA" (NO C "Potential-4"). Concentrations of contaminants in surface waters entering the treatment

facilities, are the following (DSTU[4] 3013-95): suspended solids - 500-800 mg/l, petroleum products - to 30 mg/l, BOD5- 80-100 mg 02/ l, COD - 150-200 mg O2/ l, pH - 6.5-8.0.

Treatment facilities include three blocks "EKMA-P", "EKMA-F", "EKMA B". The technological scheme of treatment of surface effluent is as follows. Effluent enters the distribution well, where contaminated sewage water (all small, medium and the estimated portion of rainwater) come for treatment the to block "EKMA-P", where trapping of the suspended solids and coarse impurities takes place, stopping and trapping of petroleum products (half deep under ground plastic wall), biodegradation and sorption of captured petroleum products (petroleum absorbing bon with filler "Zhemchug" and "Ekonadin"). After the first stage of treatment, effluent comes by gravity to the filtration block "EKMA-F", which includes coalescent filter, fine treatment filter and petroleum-absorbing bon. Next, the water flows into the unit of advanced treatment "EKMA B", in which the biological treatment in biofilters (extract from preparation "Ekonadin" cultivated on surface of load with washed crushed stone, gravel, expanded clay or biofilter material "Matala").

7.2.8. Assessment of the impact on aquatic environment

Given the location of the design object beyond coastal protection zones of water bodies, the absence of excessive discharge of pollutants into the aquatic environment, the impact on water resources is assessed as acceptable.

7.3. Solid Waste from the activities

7.3.1. Current Conditions

At present, there are two major solid waste emissions from the operations of BAS. The first is the garbage and other debris removed at the pretreatment of sewage by the debris screen. The second is the sludge removed from sewage at the end of sewage treatment process. The debris generated is approximately xxx tons per day, which are sent to a nearby solid waste incinerator, "Energiya". The excess sludge generated through sewerage treatment varies between 10,000 m^3 and 15,000 m^3, and then sent to the sludge fields. There exist three sludge disposal sites consisting of No. 1: 54.95 ha, No2: 65.0 ha, and No.3: 80.85 ha with a total area of 200.8 ha.

Utilization of sewage sludge for the agricultural purposes has been banned due to the following reasons.

[4]DSTU is an abbreviation for the State Standards of Ukraine

- High concentrations of heavy metals in sewage sludge because of acceptance of the industrial effluent which contains high concentrations of heavy metals at the time of commencing sewerage service
- Contents of the radioactive materials caused by the accident of Chernobyl nuclear power plant

Table 7-19 Characteristics of Sludge

Items / unit	Raw sludge (B1)	Raw sludge (B2)	Raw sludge (B3)	Mixture of raw sludge	Ave. of raw sludge	Excess sludge (B2)	Excess sludge (B3)	Ave. excess sludge	Digested sludge
Average water contents (%)	97.1	97.8	97.6	97.7	97.5	98.3	99.1	98.7	-
Hygroscopic moisture (%)	6.44	7.43	7.67	7.21	7.18	8.25	8.85	8.55	6.41
Solid contents (%)	2.71	2.04	2.22	2.13	2.32	1.56	0.82	1.19	-
Ignition loss (dry-%)	68.4	71.4	71.6	70.4	70.5	71.9	71.9	71.9	61.9
Ash (dry-%)	30.0	28.0	27.9	29.1	28.6	27.8	27.8	27.8	36.9
Crude fiber contents (dry-%)	8.87	7.89	8.12	8.19	8.29	5.12	4.48	4.80	9.51
Crud fat contents (dry-%)	7.49	6.32	6.45	7.64	6.75	2.40	2.44	2.42	4.48
Caloric value (kJ/kg-dry)	19,150	17,400	18,080	17,730	18,210	16,220	15,890	16,055	15,020
Caloric value (kcal/kg-dry)	4,575	4,157	4,319	4,236	4,350	3,875	3,796	3,836	3,588
Chemical element analysis									
C (dry-%)	42.4	38.2	40.1	38.9	40.2	36.8	36.2	36.5	35.5
H (dry-%)	6.77	6.11	6.46	6.15	6.45	5.85	6.02	5.94	5.73
N (dry-%)	3.40	4.67	4.79	4.49	4.29	6.45	6.33	6.39	4.86
S (dry-%)	0.67	0.69	0.76	0.66	0.71	0.40	0.54	0.47	0.62
Total S (dry-%)	0.86	0.99	1.07	0.98	0.97	0.45	0.61	0.53	0.97
Inflammable S (dry-%)	0.19	0.30	0.31	0.32	0.27	0.05	0.07	0.06	0.35
Cl (dry-%)	0.15	0.31	0.19	0.20	0.22	0.30	0.69	0.50	0.24
Total Cl (dry-%)	0.27	0.41	0.32	0.34	0.33	0.40	0.78	0.59	0.33
Inflammable Cl (dry-%)	0.12	0.10	0.13	0.14	0.12	0.10	0.09	0.10	0.09
O (dry-%)	16.61	22.02	19.80	20.50	19.48	22.40	22.42	22.41	16.15
Total florin (dry-%)	0.13	0.17	0.17	0.09	0.16	0.14	0.17	0.16	0.14

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7.3.2. Solid Wastes By Planned Operations

The design treatment facilities are expected to generate 266.439 tons of sludge. The design sludge incinerator will burn sludge cake after thickening and dewatering in special facilities.

Thus, the estimated amount of sludge, 266.439 tons per day, will be burned in a new incinerator. As a result, 117.84 tons/day of ash will form. Its chemical composition is estimated as follows:

Table 7-20 Chemical Composition of ash, %

Item	SiO_2	Al_2O_3	FeO_2	CaO	MnO	Na_2O	K_2O	TiO_2	P_2O_5	Cl^-
Ash Contents	19	20	19	9.8	1.8	0.8	0.8	0.2	26	0.02

The debris generated at the pretreatment process will remain the same in quantity and quality which will be sent to the "Energiya" as before. The planned sewerage treatment plant is expected to generate 426 tons of sludge. The proposed incinerators (4 sets with one standby) will incinerate the sludge after dewatering through compression facilities.

The calculation of the quantity of sludge is provided in the Appendices.

- Solid waste 112.266 tons/year;

The solid waste is collected during mechanical treatment and transferred for disposal to "Energiya" solid waste incineration plant.

- Ashes: 4.92 t/hour and 196.4 t/day
- Other waste
- Spent activated carbon

The calculation of hazard class is performed according to following methods set forth in DSanPiN. 2.27.029-99

$$K_i = \frac{\lg\left(LD_{50}\right)_i}{\left(S + 0{,}1F + C_в\right)_i}$$

where $K_i$is the toxicity index of each chemical ingredient that is part of the retreat, the value of K_i is rounded off to the decimal after comma;

lg (LD 50) - logarithm of the average lethal dose of chemical ingredient by ingestion (LD 50 are found in reference [1-4]);

S - coefficient which reflects the solubility of chemical ingredient in water (solubility of the chemical ingredient in water in grams per 100 grams of water at temperatures above 25 ° C is calculated by means of reference book [5], this value is divided by 100 and obtain a dimensionless coefficient S, which in most cases is in the range from 0 to 1);

F - fugacity coefficient of chemical ingredient (by means of reference book [6, 7] vapor pressure is determined in mm Hg. of output ingredients at 25 ° C with a boiling point at 760 mm Hg. to higher than 80 °C; the obtained value

is divided by 760 and obtain a dimensionless value F, which is in the range from 0 to 1);

St. - quantity of the ingredient in the total mass of output, ton / ton;

i - the serial number of a particular ingredient.

After calculating Ki for output ingredients, choose no more than 3, but not less than 2 guidelines, which have the lowest Ki , While $K_1<K_2<K_3$, except this, the condition $2K_1> K_3$ must be met.

Table 7-21 Hazard classification of waste byLD_{50}.

Value ofK_Σ, received based on LD_{50}	Hazard class	Toxicity degree
Less than 1.3	I	Extremely dangerous
From 1.3to 3.3	II	Highly dangerous
From 3.4 to 10	III	Medium dangerous
From 10 and more	IV	Not dangerous

Based on LD50 toxicity index (K_i) of each chemical ingredients is determined that are included to compound

$$K_i = \frac{\lg(LD_{50})_i}{(S+0.1F+C_B)_i}, \quad (1)$$

where lg (LD 50) i - logarithm of the average lethal dose of chemical ingredient if it enters into stomach (LD 50 determined by means of reference) / 2 - 4 /;

S - coefficient which reflects the solubility of chemical ingredient in water (solubility of the chemical ingredient in water in grams per 100 grams of water at temperatures above 25 ° C is calculated by means of reference book [5], this value is divided by 100 and obtain a dimensionless coefficient S, which in most cases is in the range from 0 to 1);

F - fugacity coefficient of chemical ingredient(by means of reference book [6, 7] vapor pressure is determined in mm Hg. of output ingredients at 25 ° C with a boiling point at 760 mm Hg. to higher than 80 ° C;

received value is divided by 760 and obtain a dimensionless value F, which is in the range from 0 to 1);

St - content of the ingredient in the total mass output in ton/ton;

Value Ki is rounded off to the decimal after comma.

Table 7-22 Ash Hazard Class and Risks

Component name	Component weight, t / t	Pressure saturated steam mm Hg	Solubility per 100 g water	LD 50 mg/kg	Hazard class	Equivalent LD 50
SiO_2	0.42	0	0	-	3	5000
Al_2O_3	0.07	0	0	-	3	5000
Fe_2O_3	0.05	0	0	-	-	5000
CaO	0.17	0	0.13	-	3	5000
MnO	0.03	0	0.0086	-	4	550
Na_2O	0.02					
K_2O	0.03					2600
TiO_2	0.007	0	0			10000
P_2O_5	0.17	0	0	-	2	150
Cl^-	0.004					

According to formula (1) the toxicity index of each chemical ingredient is calculated as follows:

$$K_1(\mathrm{Al_2}O_3) = \frac{\lg(5000)}{0+0+0.07} = \frac{3.669}{0.07} = 52.8$$

$$K_2(\mathrm{Fe_2}O_3) = \frac{\lg(5000)}{0+0+0.05} = \frac{3.669}{0.05} = 74.0$$

$$K_3(\mathrm{CaO}) = \frac{\lg(5000)}{0.0013+0+0.17} = \frac{3.669}{0.1713} = 21.6$$

$$K_4(\mathrm{MnO}) = \frac{\lg(550)}{0.000086\ +\ 0\ +\ 0,03} = \frac{2.74}{0.030086} = 91.1$$

$$K_5(\mathrm{Ti_2}O_2) = \frac{\lg(10000)}{0+0+0.007} = \frac{4.0}{0.007} = 571.4$$

$$K_2(\mathrm{P_2}O_5) = \frac{\lg(150)}{0+0+0.17} = \frac{2.176}{0.17} = 12.8$$

Then this line is placed to increase the values of the coefficients Ki, introduce a new numbering

K_1 (P_2O_5) = 12.8; K_2 (CaO) = 21.6; K_3 (Al_2O_3) = 52.8

K_4 (Fe_2O_3) = 74.0; K_5 (MnO) =91.1; K_6(TiO_2) =571.4 .

Choose the lowest toxicity index values (K i) in order to meet the following condition:$K_1<K_2<K_3$.

these values are:$K_1 = 12.8; K_2 = 21.6; K_3 = 52.8$.

But in this case, the second condition is not met:$K_1+K_2 \geq K_3$, so take only two values:

$K_1 = 12.8$; $K_2 = 21.6$and determine the total toxicity index using formula (2):

$$K_{\Sigma} = \frac{1}{n^2}\sum_{i=1}^{n} K_i = \frac{1}{4}(12.8 + 21.6) = 8.6$$

According to Table 7-22, the total hazard index corresponds to third class hazard waste - medium hazard.

All waste is temporarily stored at the facility territory in compliance with the requirements of
DSanPin 2.2.7.29-99.

Regarding waste that is not used in the company, concluded agreements exist with organizations that perform recycling and processing of waste.

Each year, the company conducts an inventory of all waste, resulting in the final set of nomenclature, the volume of formation and ways of disposal. Based on the inventory of materials, permits for generation and disposal of waste are prepared and agreed.

7.4. Impact of Electromagnetic Fields, Noise and Vibration

The negative physical impacts on humans and the environment are the following: impact of electromagnetic waves, elevated level of radiation, noise and vibration. The technological equipment is the source of noise and vibration at the station.

Monitoring of noise impacts in the BAS facilities is periodically carried out according to GOST 23337-78, and the obtained results are analyzed according to DSN 3.3.3.037-99. According to the monitoring results, the noise levels are compliant with the sanitary-hygienic requirements.

A plan of noise protection measures has been designed, including installation of station equipment on separate foundations isolated from civil engineering facilities and foundation of the architectural structures, vibro-isolating cushioning in junctions of equipment with flooring and foundations; elastic isolation of air ducts inside duct ways in civil and architectural structures, installation of anti-vibration supports in the places where air ducts or their parts directly contact walls and fencing, and installation of noise protection covers on station equipment.

According to the calculations (Volume "Protection from noise"), the level of noise on the border of the closest residential area does not exceed the maximum limits of sound impact (55 dB), thus there is no need to develop additional measures on lowering the level of noise.

Sources of electromagnetic field and ionizing radiation in the process of planned activities are not used.

8. RISK ASSESSMENT OF PLANNED ACTIVITIES ON HUMAN HEALTH

8.1. Risk Assessment of Proposed Activities on Human Health

Risk assessment of planned activities on public health from air pollution is performed by calculations of the risk of carcinogenic and carcinogenic impacts in accordance with the methodological recommendations MP 2.2.12-142-2007. "Risk assessment for public health from air pollution," which approved by Ministry of Health of Ukraine of 13.04.07 № 184. Kyiv, 2007.

8.2. Assessment of non-carcinogenic risk

The risk of development of non carcinogenic impacts determined by calculation of hazard index (HI) by the formula:

$$HI = \sum HQ_i$$

where HQ_i – danger coefficient for individual substances, which are defined by the formula (2):

$$HQ_i = \frac{C_i}{R_f \cdot C_i}$$

where Ci – estimated annual average concentration of substance on housing development line, mg/m^3;

R_fCi – reference (safe) concentration of substance mg/m^3;

$HQ_i=1$ – boundary value of allowable risk.

Assessment of non carcinogenic risk is performed with accordance with date shown in Table 8-1.

Table 8-1 Criteria for non carcinogenic risk

Risk description	Danger coefficient(HQ)
the risk of harmful impacts is very low	less than 1
Boundary value of allowable risk	1
Possibility of development of harmful impacts increases proportionally with increasing HQ	more than 1

Non-carcinogenic risk assessment for present operation is calculated by means of the utility "risk index" based on EOL 2000.

(1) **Present State Risks**

Please insert the summary of assessment by highlighting substances with high risks calculated.

Table 8-2 Non-carcinogenic Risk Assessment of Air Pollutants (Present State)

Code CAS (* group code)	Substance name (group of combined action)	Average annual concentration(Mg /m3)	Background concentration(mg / m3)	Reference (safety) concentration (mg /m3)	Danger coefficient(*Hazard Index)
*100	Impact on the breathing organs(10102-44-0, 110-54-3, 4697-37-2, 7446-09-! , 74-93-1, 7664-39-3, 7664-41 -7, 7783-06-4)		-	-	*46.3675225
7783-06-4	Hydrogen sulfide	0.04561121	0.00000000	0.0010	45.61120987
*101	Impact on the central nervous system(110-54-3, 1330-20-7, 630-08-0, 71 -43-2, 7439-92-1, 7439-96-5, 74-93-1)	-	-	-	*20.93864617
7439-96-5	Manganese and compounds	0.00103212	0.00000000	0.00005	20.64230347
*33	Summation group N 33 (10102-44-0, 630-08-0, 7446-09-5)	-	-	-	*0.37253648
*31	Summation groupN 31 (10102-44-0, 7446-09-5)	-	-	-	*0.37217348
*25	Summation group N 25 (10102-44-0, 110-54-3, 630-08-0)	-	-	-	*0.35641285
10102-44-0	Nitrogen dioxide	0.01423705	0.00000000	0.0400	0.35592636
8008-20-6	Kerosene	0.00209563	0.00000000	0.0100	0.20956263
74-93-1	Methyl mercaptan	0.00020416	0.00000000	0.0010	0.20416433
7664-41-7	Ammonia	0.01775914	0.00000000	0.1000	0.17759144
*103	Impact on blood(1330-20-7, 630-08-0, 71 -43-2,	-	-	-	*0.0920549
1330-20-7	Xylene	0.02729714	0.00000000	0.3000	0.09099048
7446-09-5	Sulfur dioxide	0.00129977	0.00000000	0.0800	0.01624711
4697-37-2	Nitric acid	0.00006622	0.00000000	0.0400	0.00165559
*107	Impact on development(71-43-2, 7439-92-1)	-	-	-	*0.00070141
71-43-2	Benzene	0.00004184	0.00000000	0.0600	0.00069735
7664-39-3	Hydrogen fluoride	0.00001813	0.00000000	0.0300	0.00060432
630-08-0	Carbon oxide	0.00108903	0.00000000	3.0000	0.00036301

110-54-3	Hexane	0.00002470	0.00000000	0.2000	0.00012348
7439-92-1	Lead and its inorganic compounds	6.099E-10	0.00000000	0.00015	0.00000407
7439-97-6	Mercury and compounds	N/A	N/A	0.0030	-
7440-43-9	Cadmium and compounds	N/A	N/A	0.0002	-
7440-62-2	Vanadsh and compounds	N/A	N/A	0.00007	-
98-01-1	Furfural	N/A	N/A	0.0500	-

№	Characteristic of risk	Pollution agent (group of combined of action)	Hazard coefficient(*Hazard index)
1	Possibility of development of harmful impacts increases proportionally with increasing HQ	100: Impact on the breathing organs 7783-06-4: Hydrogen sulfate 101: Impact on the central nervous system 7439-96-5: Manganese and compounds	46.3675225 45.61120987 20.93864617 20.64230347
2	the risk of harmful impacts is very low	33: Summation group 33 31: Summation group N 31 25: Summation group N 25 10102-44-0 Nitrogen dioxide 8008-20-6: Kerosene 74-93-1: Methyl mercaptan 7664-41-7: Ammonia 103: Impact group on blood 1330-20-7: Xylene 7446-09-5:0 dioxide 4697-37-2: Nitric Acid 107: Impact on development 71-43-2: Benzene 7664-39-3: Hydrogen fluoride 630-08-0: Carbon monoxide 110-54-3: Hexane 7439-92-1: Lead and its non-org. compounds.	0.37253648 0.37217348 0.35641285 0.35592636 0.20956263 0.20416433 0.17759144 0.0920549 0.09099048 0.01624711 0.00165559 0.00070141 0.00069735 0.00060432 0.00036301 0.00012348 0.00000407

(2) **Risks After Reconstruction**

Non-carcinogenic risk assessment for proposed operation is calculated by means of the utility "risk index" based on EOL 2000 in Table 8-3. *Risk of carcinogenic impacts:* ***risk of harmful impacts is very low.***

Table 8-3 Non-carcinogenic Risk Assessment of Air Pollutants (After Reconstruction)

Code CAS (* group	Substance name (group of combined action)	Average annual concentration(Mg /m3)	Background concentration(mg / m3)	Reference (safety) concentration	Danger coefficient(*Hazard Index)

code)				(mg /m3)	
*101	Impacts on central nervous system (110-54-3, 1330-20-7, 630-08-0, 71 -43-2, 7439-92-1, 7439-96-5, 7439-97-6, 74-93-1)	-	-	-	*5.13575557
7439-96-5	Manganese and compounds	0.00025346	0.00000000	0.00005	5.06928539
*100	Impact on respiratory system(10102-44-0, 110-54-3, 4697-37-2, 7440-43-9, 7446-09-5, 74-93-1, 7664-39-3, 7664-41-7, 7783-06-4)	-	-	-	*3.31062601
7783-06-4	Hydrogen sulfide	0.00272557	0.00000000	0.0010	2.72557425
*33	Hydrogen sulfide N 33 (10102-44-0, 630-08-0, 7446-09-5)	-	-	-	*0.33279305
*25	Hydrogen sulfide N 25 (10102-44-0, 110-54-3, 630-08-0)	-	-	-	*0.30663774
*31	Hydrogen sulfide N 31 (10102-44-0, 7446-09-5)	-	-	-	*0.30105875
10102-44-0	Nitrogen dioxide	0.01099172	0.00000000	0.0400	0.27479291
7664-41-7	Ammonia	0.02390276	0.00000000	0.1000	0.23902754
*103	Impact on blood(1330-20-7, 630-08-0,	-	-	-	*0.04644214
630-08-0	Carbon monoxide	0.09520291	0.00000000	3.0000	0.0317343
7446-09-5	Sulfur dioxide	0.00210127	0.00000000	0.0800	0.02626584
74-93-1	Methyl mercaptan	0.00001924	0.00000000	0.0010	0.01923888
*107	Impact on development (71-43-2, 7439-92-1)	-	-	-	*0.01426455
7664-39-3	Hydrogen fluoride	0.00041381	0.00000000	0.0300	0.01379359
7439-92-1	Lead and its non-organic compounds	0.00000204	0.00000000	0.00015	0.01357239
7440-43-9	Cadmium and compounds	0.00000204	0.00000000	0.0002	0.01017929
8008-20-6	Kerosene	0.00003622	0.00000000	0.0100	0.0036215
4697-37-2	Nitric acid	0.00006573	0.00000000	0.0400	0.00164316
71-43-2	Benzene	0.00004153	0.00000000	0.0600	0.00069217
7439-97-6	Mercury and compounds	0.00000204	0.00000000	0.0030	0.00067862
1330-20-7	Xylene	0.00013299	0.00000000	0.3000	0.00044329
110-54-3	Hexane	0.00002211	0.00000000	0.2000	0.00011053

7440-50-8	Copper and compounds	N/A	N/A	0.00002	-
7440-62-2	Vanadium and compounds	N/A	N/A	0.00007	-
98-01-1	Furfural	N/A	N/A	0.0500	-

№	Characteristics of risk	Contaminating substance (group of combined action)	Hazard rate (*hazard index)
1	Possibility of development of the hazardous effects grow proportionally to the increase of HQ	101:Impact group of CNS 7439-96-5:Manganese and compounds 100:Impact group on respiratory organs 7783-06-4:Hydrogen sulfide	21.83142504 21.77014923 3.0578597 2.49743319
2	Risk of hazardous effects is quite small	33:Summation group N 33 25:Summation group N 25 31:Summation group N 31 10102-44-0 :Nitrogen dioxide 7664-41-7:Ammonium 103:Impact group on blood 630-08-0:Carbon oxide 7446-09-5:Sulphur dioxide 74-93-1 :Methyl mercaptan 107:Impact on development 7664-39-3:Hydrogen fluoride 7439-92-1:Lead and its non-organic substances . . . 7440-43-9:Cadium and compounds 8008-20-6:Kerosene 4697-37-2:Nitric acid 71-43-2:Benzol 7439-97-6: Mercury and compounds 1330-20-7:Xylol 110-54-3:Hexane	0.31866456 0.29350036 0.28928654 0.2640118 0.24064647 0.04224448 0.02937803 0.02527474 0.01833424 0.01242317 0.011731 0.00879825 0.0036215 0.00164316 0.00160732 0.00069217 0.00058655 0.00044329 0.00011053

8.3. Assessment of Carcinogenic Risks

The risk of individual carcinogenic impacts from substances ICR_1 which are subject to carcinogenic impacts is calculated as:

$$ICR_i = C_i \cdot UR_i$$

where C_i – estimated average concentration of substance on the edge of residential development, mg/m^3;

UR_i – only carcinogenic risk-related substance, mg/m3.

Carcinogenic risk of the combined impacts of multiple carcinogens, polluting the atmosphere (CRa) is defined by formula (4):

$$\tilde{N}R_{\grave{a}} = \sum IRC_i$$

where IRC_i – carcinogenic risk and i-i substance, mg/m3.

Evaluation of carcinogenic risk is managed according to the classification of levels of carcinogenic risks listed in Table 8-4

Table 8-4 Classification of carcinogenic risk levels

Level of risk	Risk for life
Unacceptable for professionals and public	more than 10^{-3}
Acceptable for professionals and unacceptable for public	10^{-3} - 10^{-4}
Generally acceptable	10^{-4} -10^{-6}
Acceptable	less 10^{-6}

Unit risk value is calculated using SF, standard body weight of human (70 kg) and daily intake air (20 m3):

$$UR_i\ (m^3/mg) = SF_i\ (mg/kg \times day)^{-1} \times 1/70\ kg \times 20\ (m^3/day)$$

Carcinogenic risk assessment for present operation is calculated by means of the utility "risk index" based on EOL 2000.

(1) **Present State Risks**

Table 8-5 Carcinogenic Risk Assessment of Air Pollutants (Present State – above the line, after reconstruction – below the line)

Code CAS (* group ID)	Substance name (group of combined action)	Avg. yearly concentration (mg /m3)	Background concentration(mg/m3)	Carcinogenic potential factor (SF) (mg/kg*day)	Unit risk (UR) (m3 / mg)	Individual carcinogenic risk carcinogenic risk the combined action)
71-43-2	Benzene	0.00003664 0,00004153	0.00000000	0.0270	0.00771429	0.00000028 0,00000032
*101	Impact on central nervous system (71-43-2, 7439-92-1)	-	-	-	-	*0.00000028 *0.00000034
*103	Impact on blood (71-43-2, 7439-92-1)	-	-	-	-	*0.00000028 *0.00000034
*107	Impact on development (71-43-2, 7439-92-1)	-	-	-	-	*0.00000028 *0.00000034
50-32-8	Benzo (a) pyrene	ND 0.00000039	ND 0.00000000	3.1000	- 0,88571423	- 0.000000423
7439-92-1	Lead and its inorganic compounds	4.896E-10 0.00000176	0.00000000	0.0420	0.0120	5.875*10E-12 0.00000002
7440-02-0	Nickel	ND 0.00000176	ND	6.3000	- 1.80000007	- 0.00000317
7440-38-2	Arsenic	0.00003664 0,00004153	0.00000000	0.0270	0.00771429	0.00000028 0,00000032
7440-43-9	Cadmium and compounds	-	-	-	-	*0.00000028 *0.00000034

The carcinogenic risk of planned activities by contaminants and impact groups increases somewhat; however, by levels of influence it remains acceptable. By cadmium and its compounds, the risk is conditionally acceptable.

9. ASSESSMENT OF IMPACT ON ENVIRONMENT DURING THE CONSTRUCTION

9.1. Construction Work

According to the design in terms of reference, treatment facilities, the engineering infrastructure, landscaping, treatment and sludge disposal technology are going to be fully reconstructed in a sequence.

Construction Organization section (Volume 11) lists and explains the needs for each of the Components:

- for the main construction machinery, vehicles;
- for electric power;
- adopted duration of construction for each cycle of works;
. manpower and related facilities.

A list of construction machinery and their impact estimation is included in Appendix E: Construction Machinery and Estimated Emissions.

Construction works should be carried out only within the permanently allocated land of the BAS. A temporary construction site is provided. Special construction sites outside of the permanently allocated of land are not provided. After the completion of construction, the temporary construction site and buildings on it are to be dismantled. Energy, drainage, wastewater treatment and water supply is ensured for the construction site by temporary communication networks. The main construction works are carried out using mobile equipment and facilities. Constructions will be made at factories, and only their fitting and connections will be made directly on construction site. A special plant provides concrete works. Concrete will be delivered to the site in "mixers," where dusting does not take place. There will be placement of boilers, technical maintenance and repair of motor vehicles, painting works, metal works, charging batteries, repairing rubber products, machining materials, copper works, repairing and testing motors, fuel equipment, washing parts, components, and assemblies. In addition construction machinery works, the technological operations of welding and cutting metal are the most dangerous for the workers. Construction must be carried out using the developed technological scheme, which provides measures to reduce environmental impact:

- Protection of ambient air from chemical and physical contamination is achieved by devising schedules of operation of construction vehicles and mechanisms, which would eliminate the simultaneous operation of all defined

construction vehicles and mechanisms, stopping operation of mechanisms that create excessive acoustic pollution in during night shifts;

- Preparation of the construction site with organization of temporary drainage of surface deposits;
- Storage of excavated soil directly from the excavation; accumulation of construction waste in specially prepared area, followed by its removal.
- Works of preparatory period start with fencing the construction site, providing the construction site with water and electricity, installation of temporary buildings and facilities, construction of access roads to design regular roads;
- Providing construction with concrete and mortar is to be done by centralized delivery including the use of concrete mixers. Dust-generating construction materials (cement, sand) are to be stored in closed bins. All works on unloading construction materials must be performed by means of "mounting from vehicles".

To carry out construction works, (in the active construction period) equipment is applied (excavators and bulldozers for excavation and loading operations; crane for installation of temporary construction facilities, construction of reinforced concrete elements of wells, unloading, etc.), which provides temporary negative impact on the atmosphere.

9.2. Air Pollution During Construction Work

There is temporary air pollution by exhaust gases generated by vehicles, bulldozers, excavators, cranes and pollutant emissions during welding works. Emissions of pollutants during operation of internal combustion engines (ICE) are defined according to the "Method of calculating pollutant emissions by mobile sources", developed by JSC "UkrNTEC" in terms of specific pollutant emissions based on fuel consumption. The mass of emission of j-th harmful substance (t) by rolling stock of road transport that has n groups of k-type vehicles for the period of T is determined depending on:

$$M_j^{\tau} = \sum_{i=1}^{m} g_{jci} \cdot G_i^{\tau} \cdot K_{\grave{o}} \cdot 10^{-3}$$

where g_{jci} – average specific emission of j-th harmful substance of the unit of consumed i-th fuel, kg/t;

G_i^{τ} - fuel consumption, t;

K_∂ - coefficient that considers impact of the technical condition of vehicles on the value of specific emissions.

Calculations of emissions are provided in Table 9-1.

Table 9-1 Calculation of emissions from ICE operation

Pollutant	Specific emission, kg/t	Coefficient K_∂	Fuel Consumption		Emission	
			t/hour	t/year	g/s	t/year
NO_2	31.5	0.95	0.002	4.032	0.017	0.121
Soot	3.85	1.8	0.002	4.032	0.004	0.028
SO_2	5	1	0.002	4.032	0.003	0.020
CO	36	1.5	0.002	4.032	0.030	0.218
CH	6.2	1.4	0.002	4.032	0.005	0.035

The amount of dust released during movement of soil is determined according to "Manuals for calculating emissions from non-organized sources in the building materials industry, " Soyuzstromekolohiya, 1989, using the formula:

$$q=\frac{K_1 \cdot K_2 \cdot K_3 \cdot K_4 \cdot K_5 \cdot K_7 \cdot G \cdot 10^6 \cdot B'}{3600}, \text{ g/s,}$$

$$q=K_1 \cdot K_2 \cdot K_3 \cdot K_4 \cdot K_5 \cdot K_7 \cdot G \cdot B', \text{ t/hr,}$$

where K_1 – weight fractions in the dust particle of material;

K_2 – part of dust that enters into aerosol;

K_3 – Coefficient considering local weathe r conditions (with annual average wind speed for these conditions up to 5 m/s), K3= 1.2;

K_4 – coefficient considering local conditions;

K_5 – coefficient considering humidity of materials;

K_7 – coefficient considering size of the material;

G – total quantity of material processed t/ hour (t / year);

B' – coefficient, considering height of pouring;

Dusting occurs at moving soil. Initial data for calculation:

Material	K_1	K_2	K_3	K_4	K_5	K_7	G, t/hr	G, t/year	B'
Soil	0.05	0.02	1.2	1.0	0.01	1.0	70	99640	1.0

Dust emission at performance of excavation will make:

$$q = \frac{0{,}05 \cdot 0{,}02 \cdot 1{,}2 \cdot 1{,}0 \cdot 0{,}01 \cdot 1{,}0 \cdot 14 \cdot 10^6 \cdot 1{,}0}{3600} = 0.047 \text{ g/s.}$$

$$q = 0{,}05 \cdot 0{,}02 \cdot 1{,}2 \cdot 1{,}0 \cdot 0{,}01 \cdot 1{,}0 \cdot 99640 \cdot 1{,}0 = 1.196 \text{ t/year.}$$

Calculation of emissions from welding work is done according to the method "Emission indicators (emissions per unit) of pollutants from the processes of electricity, gas welding, welding, electrical, gas cutting and deposition of metals", approved by Ministry of Nature on January 11, 2003.

Specific emissions of pollutants during the welding of electrodes are provided in Table 9-2.

Table 9-2 Specific pollutant emissions during welding

Type	Amount of substances emitted, g / kg of welding materials	
	Particulate materials	
	Iron (III) oxide Fe_2O_3	Manganese (IV) oxide MnO_2
ANO-6	14.35	1.95

Consumption of electrodes during welding works on electrodes is shown in Table 9-3.

Table 9-3 Consumption of electrodes during welding work

Electrode type	Consumption of electrodes	
	kg/year	kg/hour
ANO-6	53.167	1.0

Pollutant emissions with consideration of the annual fixed charges are shown in Table 9-4

Table 9-4 Calculation of emissions during welding works

Type	Pollutant emissions			
	Particulate materials			
	Iron (III) oxide Fe 2 O 3		Manganese (IV) oxide MnO_2	
	g/s	t/year	g/s	t/year
ANO-6	0.003986	0.0007	0.000542	0.000104

		63		

The list of pollutant agents and their total emissions is shown in Table 9-5.

Table 9-5 List of Pollutant Agent

Name of pollutant agent	Code of substance	Hazard class	MPC, mg/nm^3	Second emission, g/s	Gross emission, t/year
Iron oxide	123	3	0.4	0.003986	0.000763
Manganese and its compounds	143	2	0.01	0.000542	0.000104
Carbon Monoxide	301	3	0.2	0.017	0.121
Soot	328	3	0.15	0.004	0.028
Sulfur dioxide	330	3	0.5	0.003	0.020
Carbon oxide	337	4	5.0	0.030	0.218
Limit carbon	2754	4	1.0	0.005	0.035
Pyruvic acid in%: lower 20	2909	3	0.5	0.047	1.196
Total:				0.110528	1.618867

In order to simplify the calculation, OND-86 determines the suitability of calculating for ingredients, each enterprise considers only those substances for which:

$$\frac{\mathrm{M}}{\mathrm{MPD}} > 0.1 \text{ for } \mathrm{H} < 10m;$$

$$\frac{\mathrm{M}}{\mathrm{MPD}} > 0.10 \text{ for } \mathrm{H} < 10m;$$

where: M - power of ingredient emission, g/s;

MPD - value of maximum one-time discharge limit, mg/m 3;

H - average weighted release height, m.

Calculation of reasonability shown in Table 9-6.

Table 9-6 Calculation of reasonability

Ingredients	M; / s	Emission limit mg / m^3	M / emission limit	Coefficient of reasonabilty	Reasonability of the scattering calculation
Iron oxide	0.003986	0.4	0.010	0.1	No
Manganese and compounds	0.000542	0.01	0.054	0.1	No
Nitrogen Dioxide	0.017	0.2	0.085	0.1	No
Soot	0.004	0.15	0.027	0.1	No
Sulfur dioxide	0.003	0.5	0.006	0.1	No
Carbon oxide	0.030	5.0	0.006	0.1	No
Marginal carbon	0.005	1.0	0.005	0.1	No
Pyruvic acid in %: <20	0.047	0.5	0.094	0.1	No

The calculations of dispersion of pollutant emissions during maximum volume of construction works were not performed due to their unfeasibility.

9.3. Noise During Construction.

9.3.1. Noise Estimation

During construction works, it is planned to use a typical set of road construction machinery and mechanisms the noise characteristics of which are determined according to the catalog [Evdokymova, 1975; Reducing noise in the building and residential areas. Moscow: Stroiizdat, 1987; Protection from noise during construction. A designer's reference. Moscow: Stroiizdat, 1993 Instructions on development of "Environment protection" chapter of project documentation on feasibility study stage of project for construction in the city of Moscow", M. 1994 Moscow. " M. 1994.

Table 9-7 Calculation of Noise

Road-construction machines and mechanisms	L. A. equivalent dBA	Exceeding MPA. Equiv.	
		рз	MPC
Drilling machine	70	-	5
Dump truck carrying capacity 12 t	68	-	3
Drop-side truck carrying capacity 5-7 t	65	-	-
Movable compressor to 12 m^3 / min HB-10	80	-	15

The speed of road machinery of up to 10 km per hour is approved.

9.3.2. Impact on Population

The least stringent sanitary regulations for the population specify a maximum allowable level equivalent to day/night = 65/55 dBA and maximum allowable level max. day/night = 80/70 dBA. In places of machinery concentration during simultaneous operation, equivalent noise level can reach L. A. eq. constr. = 75 to 80 dBA.

Table 9-8 Noise Impact

Machines, machinery and equipment for the construction of artificial structures	L. A. equivalent dBA	ExceedingMP A. Equiv.	
		рз	Нас
Drilling Machine	70	-	5
Concrete pump	70	-	5
cement bulk truck carrying capacity 7 t	70	-	5
Dump truck carrying capacity 12 t	68	-	3
drop-side truck carrying capacity 5. . . 7 t	65	-	-

Temporary noise impact has the width of acoustic discomfort zone varies between 15m to 200 m. Sanitary regulations for the working area permit a maximum allowable noise level equivalent to = 80 dB. Worn-down and obsolete road-building machines and mechanisms

create the highest noise level on the workplace. The use of outdated technology is not expected. The use of personal noise protective equipment is highly recommended.

9.3.3. Vibration Impact During Construction

During construction, it is planned to use a typical set of road-building machinery and equipment. Vibration may be caused by machines and mechanisms during construction works, that are built based on the technology of shock and vibration loads – pile driving or vibro-deepening. Lower vibration levels are created by compressors and jackhammers. Values of vibration acceleration from construction equipment in all octaves are 0.04 to 0.1 m /s^2 – which is less than 1% of the acceleration of gravity. La. o = 3 * 10^{-4} m/s^2. Thus, construction equipment generates vibrations with acceleration levels in the range of La. V = 42.5 to 50.5 dBV.

Regarding the population, unstable temporary vibration by impact on construction road work in daytime is evaluated as acceptable corrected level of vibration acceleration maximum allowable level at a. V = 40 dBV. Considering the existing geological and hydrological conditions of the impact zone of construction equipment on the population is between 5m and 25 m

The average adjustment coefficient of reduction acceleration level during moving from the soil to the foundation 0.56 or 20 lg 0.56 = - 5 dBV, which reduces vibration influence to the level L. a. V. foundation = 40 dBA to 45 dBA. Reducing the acceleration (e - 0.023 R) to the level of maximum allowable level. a. V = 40 dBV takes place at a distance of 5.1m to 5.5 m from the source. Thus, during construction works, sanitary regulations for the population regarding vibration displacement are complied with directly on the border of the construction area.

Regarding constructions for standard of accessibility vibration impact of construction work is accepted the vibration acceleration 3% (0.294 m/s^2 or 59.8 dBV) from the acceleration of gravity for old buildings and 10% (0.98 m/s^2 or 70.3 dBV) - for modern sustainable constructions.

Intense vibrations with a wide range of frequencies recorded on the handle of a hammer and on chisel. Left hand of worker is exposed by considerable vibration (within 150 cm to 215 cm / s), which holds the chisel. The right hand that holds a pen is exposed by vibration of 36 cm / s [Homyak, Skorchenko, 1983].

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9.4. Assessing Impact of Construction

Works are carried out in the BAS and Right Bank SPS, all of which are in the industrial and transportation zone. The nearest residential development is located at 600 m away. The impact of construction on natural objects, the environment of human life and surrounding buildings and constructions complies with regulations. For other pollutants (CO, dust, cement, etc.) at OND-86 calculation is impractical. The least stringent health standards for the population are MPL. equiv. day/night = 65/55 dB and MPL. max. day/night = 80/70 dB. In the areas of technology location with its simultaneous operation, the equivalent noise level can reach L. A. equiv. constr. = 75 dB to 80 dB.

For the population, the unstable vibration of temporary construction road work during the daytime is rated at acceptable level of corrected acceleration MPL. a. V = 40 dBV. The existing geological and hydrological conditions, zone of influence of construction equipment on the population is 5m to 25 m.

the average adjustment coefficient of reduction level of vibration acceleration when moving from the soil to the ground 0.56 or 20 lg 0.56 = -5 dBV, which reduces vibration to the level L. a. V. fund = 40 dB to 45 dB. Reducing the vibration acceleration (e - 0.023 R) to the level MPL. a. V = 40 dBV takes place at a distance of 5.1m to 5.5m from the source. Thus, during the construction, sanitary norms for the population regarding the vibration displacement performed directly on the border of the construction site.

10. PUBLIC HEARING

10.1. General Schedule

With the purpose of informing the public, NGOs and mass media about the public discussion process being launched into an active phase on September 27, 2013, an announcement was placed at the official PJSC "Kyivvodokanal" website http://www.vodokanal.kiev.ua. The details of public hearings are contained in Appendix G: Public Hearing Records. On October 7, 2013 a specially prepared press release about the procedure and the process of public discussion of the project "Reconstruction of sewage waste water treatment facilities and construction of production line for sludge processing and utilization at Bortnychi aeration station" was placed there. On September 30 and October 7 respectively, similar announcements for the public were placed at the official Kyiv city state administration website http://kievcity.gov.ua and at the official web page of Darnytsia district state administration in the city of Kyiv. According to requirements of the "Arrangements for involvement of the public into discussion of issues regarding decision making which may have impact on the state of environment" approved by the Cabinet of Ministers of Ukraine on June 29, 2011, No.771, information about holding of a public hearing on issues of the project "Reconstruction of sewage waste water treatment facilities and construction of production line for sludge processing and utilization at Bortnychi aeration station" was placed in the newspaper of Kyiv city council "Khreshchatyk" of October 4, 2013 No. 144 (4351) and at the website of the Company. Before the public discussion started, a separate section (banner) "Public discussions" was created, where information on the public discussion of BAS reconstruction project was placed.

10.2. Public Announcements

Announcements about the public discussion and the public hearing concerning the project "Reconstruction of sewage waste water treatment facilities and construction of production line for sludge processing and utilization at Bortnychi aeration station" were sent out by press service of PJSC"Kyivvodokanal" to e-mails of leading national and municipal information agencies, namely: "UNN", "UNIAN", "Interfax", "Liga", "RBK", "Ukrinform", "Ukraina Komunalna"(Communal Ukraine), "Regionews", "Nash produkt"(Our produkt); radio stations "Holos Kyieva"(Voice of Kyiv) and "KyivFM"; print media "Segodnia"(Today), "Komsomolskaia Pravda v Ukraine"(Komsomol Truth inUkraine), "Korrespondent", "Khreshchatyk". Besides, invitations to the public hearing were

additionally faxed to a number of leading TV-channels, namely: “Channel 5”, “News 24”, “24ua”, “First business channel”, “First NationalChannel”, “TRK “Ukraine”, “TRK “Kyiv”, “1+1”, “Inter”, “STB”, “Novyi Kanal”(New Channel), “KDRTRK”, “TRK “Era”, “ICTV”, “ICTV “Nadzvychaini Novyny”(Extraordinary News).

10.3. Public Discussion

With assistance of Kyiv city state administration the public hearing on the project “Reconstruction of sewage waste water treatment facilities and construction of production line for sludge processing and utilization at Bortnychi aeration station” was held in the assembly hall of Darnytsia district state administration in the city of Kyiv at 11 Koshytsia street, Kyiv. To establish a contact with interested citizens and NGOs representatives, while the public discussion was in its active phase, since the day when the announcement about holding the public hearing was published in “Khreshatyk” newspaper and to the final day of the public discussion, transparent letterboxes were installed at the main PJSC "Kyivvodokanal" office at 1A Leiptsyzka Street and at Darnytsia district state administration in the city of Kyiv at 11 Koshysia Street for collecting questions, remarks and suggestions of the public. To receive e-mail requests from the public representatives, a single address of the PJSC "Kyivvodokanal" press service was defined: press@vodokanal.kiev.ua. The public hearing on issues of the project “Reconstruction of sewage waste water treatment facilities and construction of production line for sludge processing and utilization at Bortnychi aeration station” was held on October 10, 2013 in the assembly hall of Darnytsia district state administration in the city of Kyiv at 11 Koshytsia Street.

Before the public hearing started, the Company organized registration of participants. 189 people registered to participate in the public hearing on issues of the project “Reconstruction of sewage wastewater treatment facilities and construction of production line for sludge processing and utilization at Bortnychi aeration station”.

Before the public event started, participants of the public hearing were shown an awareness-raising film specially prepared by the PJSC "Kyivvodokanal" and devoted to topical issues of sewage system and treatment facilities in Ukraine. The agenda of the public hearing included:

- Speech by the first deputy head of Kyiv City State Administration;
- Speech by the chairman of the board of PJSC “Kyivvodokanal”;
- Speech by the director of “Kyivinzhproekt” Institute, a branch of PJSC “Kyivproekt”;
- Speech by the head of LLC “Ekoton”;

- Presentation of the project “Technologies planned to be introduced at Bortnychi Aeration Station and examples of their application at similar objects in Europe and throughout world” by technical director of the French company “Sources”;

- Presentation of the project “Production lines which are planned to be introduced at BAS and practice of their operation in Japan” by a member of environmental assessment working group of Japan International Cooperation Agency (JICA);

- Suggestions and remarks by representatives of the public;- Replies to suggestions and remarks of participants of the public hearing;

- Summarizing the public hearing.

With the aim of collecting and processing questions, remarks and suggestions of the public audio and video recordings of the public hearing were made. On completion of the public hearing press service of the Company held a briefing for mass media representatives. On October 10, 2013 the following pieces were broadcasted on TV channels to the topic of the conducted public hearing.

- “A billion Euros requested to save Kyiv from sewage”

- TRK “Ukraine”

- “BAS reconstruction may start as soon as next year”

- “Kyiv” Channel

- “Kyiv government presented a plan to reconstruct treatment facilities in Bortnychi” - “Channel5”

- “BAS reconstruction to start in 2014”

- “BTB” Channel

On the next day after the public hearing on the project “Reconstruction of sewage waste water treatment facilities and construction of production line for sludge processing and utilization at Bortnychi aeration station” the PJSC "Kyivvodokanal" the press service conducted appropriate monitoring of mass media as to coverage of issues, discussed at the public hearing.

10.4. Public Comments

During 30 days since the day when an announcement about the public hearing was published in “ Khreshchatyk” newspaper, 5 suggestions concerning the project “Reconstruction of sewage wastewater treatment facilities and construction of production line for sludge processing and utilization at Bortnychi aeration station” were received by PJSC "Kyivvodokanal". All listed suggestions had been sent to the e-mail address of the

Company's press service. Part of suggestions sent by representatives of the public to the address of the organizer of the public discussion concerned issues of cooperation with the Company in the direction of BAS production. Other suggestions (remarks) from representatives of the public, which concerned directly the issues of the presented reconstruction project "Reconstruction of sewage waste water treatment facilities and construction of production line for sludge processing and utilization at Bortnychi aeration station" were sent by the organizer of the public discussion to "Kyivinzhproekt" Institute, a branch of PJSC "Kyivproekt", for their processing.

From the content of responses to the suggestions (remarks) by experts of "Kyivinzhproekt" Institute, a branch of PJSC "Kyivproekt", the Company drew a general conclusion that the nature of these suggestions is such that there is no necessity to consider them in the project "Reconstruction of sewage waste water treatment facilities and construction of production line for sludge processing and utilization at Bortnychi aeration station".

After events within the framework of the public discussion of the project "Reconstruction of sewage waste water treatment facilities and construction of production line for sludge processing and utilization at Bortnychi aeration station" were finished, these materials containing a description of activities and results of the Company's work regarding the raised issue were prepared. Printed copies of the public discussion materials were sent to the executive body of Kyiv city council (Kyiv city state administration) in full volume. Text of the materials must be placed at the official website of PJSC "Kyivvodokanal" http://www.vodokanal.kiev.ua.

10.5. Conclusions

Presented information about organization, holding and results of the public discussion of the project "Reconstruction of sewage waste water treatment facilities and construction of production line for sludge processing and utilization at Bortnychi aeration station" allows to draw the following main conclusions:

- In the course of the public discussion all requirements of acting legislation of Ukraine regarding arrangements, terms and volume of informing the public about planned activities of BAS were met. All NGOs and citizens that expressed their interest were given an opportunity to participate in the public discussion. At the same time, scheduled events of discussion

process mostly involved Kyiv population, whose territory may be affected by BAS planned activities, and the population, connected with BAS activities socially and economically;

11. COMPREHENSIVE MEASURES FOR PROVIDING NORMATIVE CONDITION OF THE ENVIRONMENT

11.1. Air Pollution Mitigation Measures

11.1.1. Odor Removal

The current odor is removed with the use of activated carbon filters during the processes of wastewater treatment. The ordor-containing air emitted during the process of sludge dewatering will be channeled into the incinerators to be combusted.

11.1.2. Air Scrubber

A planned installation of air scrubbers will eliminate a large portion of emission of sulfuric oxidants by absorption into water as described in 5.2.1, (11).

11.1.3. Electric Filter

An electric filter “bug filter” will remove 99.1% of the dust emissions from the chimneys of incinerators.

11.2. Aquatic Pollution Mitigation Measures

11.2.1. Sewage treatment facilities of car washes and industrial wastewater treatment facilities for wash units and motors

The aim of implementation of the project for wastewater treatment facilities for device and engine washing is to provide the required degree of treatment of highly concentrated wastewater for their possible removal into household sewage system of the city of Kyiv, as well as improving the quality and characteristics of sediment and biological decomposition of petroleum products.

The Component 10 of construction of motor transport and repair units includes the placement of wastewater treatment facilities of car wash and facilities of industrial water from washing units and engines. The capacity of treatment facilities is Q_{avg} = 3.85 m3/h, Q_{daily} = 38.50 m3/day, Q_{annual} = 14052.5 m3/year. The capacity of treatment plant is Q_{daily} = 0.50 m3/day (1 per week), Q_{annual} = 26.0 m3/year.

Waste water facilities of washing devices and motors provide:

- treatment of highly concentrated wastewater from suspended solids, petroleum products, detergents and phosphates and their dilution to safe parameters for removal into household sewer in Kyiv;

- use of coagulant for binding phosphates;

- use of high-molecular flocculants for compaction of sediment to reduce its mass and volume;

- use of biological decomposition of petroleum products and surfactants to improve the quality characteristics of sediment;

- possibility of cleaning filters with industrial water;

- regular monitoring of treatment plants for compliance with the required level of clearance to the standard indicators.

Monitoring the quality of circulating water is provided by sampling of treated water and making analysis for regulated performance indicators in an accredited laboratory. Equipment of sewage treatment facilities of reverse supply wastewater from car washes is located in a separate building of industrial component of motor transport, that is projected. The premises of reverse water treatment facilities are adjacent to the premises of portal car washes and facilities form annual car washing. The equipment of wastewater treatment facilities from device washing units and motors is located in a separate room of the designed building. the premises of wastewater treatment facilities from washing units and motors is adjacent to the premise of unit washing area.

11.3. Solid Waste Disposal

11.3.1. Ashes

Incineration of sludge will generate ashes approximately. The daily volume of ashes is expected to be 4.9 tons. The chemical composition of ashes is shown in Table 11-1.

Table 11-1 Chemical Composition of Ashes

Unit: wet weight %

Item	SiO_2	Al_2O_3	FeO_2	CaO	MnO	Na_2O	K_2O	TiO_2	P_2O_5	Cl^-
Ash Composition	19	20	19	9.8	1.8	0.8	0.8	0.2	26	0.02

JICA Study Team

Final disposal of sewage sludge should be considered mainly from the viewpoints of sustainability and mitigation of environmental impact. Nowadays, utilization of sewage sludge is encouraged so as to assist the establishment of material recycling society. The final form of sewage sludge is ash since the sludge treatment process includes incineration. Utilization of ash as construction materials is summarized as shown in Table 11-2.

Table 11-2 Utilization of Ash as Construction Materials

Utilization	Contents
Ingredient of Cement	The chemical components of ash are generally similar to those of clay ingredient for cement. Hence, ash is utilized to produce cement as substitute of clay.
Ingredient of Asphalt	Ash is utilized to produce asphalt mixture as substitute of asphalt filler.
Concrete Products	Ash is utilized to produce concrete products such as interlocking blocks, reinforced concrete pipes, street gully and system manhole.
Calcination Products	Ash is utilized to produce calcination products such as tiles, bricks (normal brick, interlocking brick, etc.), clay pipes, aggregate and soil improvement material.

Source: JICA Study Team

The hazard class of the spent (used) activated carbon will be determined after clarification of content of the new ash. The carbon, after passing through the filter (second stage of cleaning) must be disposed of on special landfill sites. After receiving the first samples of the mentioned waste, its chemical quality and hazard class will be determined and the means of its disposal will be established.

11.3.2. Other Wastes

Waste metalwork, woodwork and packaging material will be generated in the process of production and business activities of the facility, as well as wiping material, waste from maintenance of vehicles and mechanisms, volatile ash, which is delayed by electrostatic filters, waste from the operation of sewage treatment plants, household and domestic waste.

During the operation of local treatment facilities of surface during the treatment of water, sludge (4th class of hazard) will be formed, which is accumulated, mineralized and exported for disposal (solid waste landfilling) 2 times a year. Biologically active additive "Ekonadin" is added to the waste, which promotes biodegradation of organic pollution and petroleum products. Sediment composition: mixture of sand, minerals, sludge and petroleum products of biodegradation. In addition, there will be generated waste of petroleum absorbing bons (2 units per year), which contain organic pollution, perlite, products of biological decomposition of petroleum products, refer to hazard class 4 and can be utilized by placing of solid waste on landfill.

Waste from mechanical treatment of metal (polling tools, units of mechanical machinery) will be collected in metal boxes for disposal. Wood waste is collected in a metal box for disposal. Welding section waste (welding electrodes, welding slag) is srore in a metal box for disposal.

The maintenance of machinery and mechanisms is connected with waste generation of waste tires, used motor oil, oily cleaning pads. Petroleum products and wiping materials are collected separately in sealed containers.

Table 11-3 Solid Wastes and Disposal plan in BAS

Waste	Hazard class	Code of waste	Meas. unit	Total	Method of disposal (utilization)
Communal waste (city)	4	7720.3. 1.01	t/year	112	Plant «Energia»
Remains of tree trimming and care of plantings	4	0113.2. 9.01	t/year	24	Plant «Energia»
Waste from mixed construction and demolition of buildings and structures	4	4510.2. 9.09	t/year	300	Landfill №6
Waste received during cleaning of streets, places of public use	4	7720.3. 1.03	t/year	1	Plant «Energia»
Wood and wooden products	4	7710.3. 1.10	t/year	3	Plant «Energia»
Ferrous steel metals minor	4	7710.3. 1.08	t/year	60	LLC TPK “Ukrasplav”
Ferrous color metals minor	4	7710.3. 1.09	t/year	1.5	LLC TPK “Ukrasplav”
the share of municipal waste and similar non-specific industrial, not processed into compost during the treatment	4	9010.2. 3.07		3060	Plant «Energia»
Sludge from treatment of waste water non-specific industrial	4	9030.2. 9.04		108,712	At the enterprise
Residues received during the extraction of sand	4	9030.2. 9.02		8,262	At the enterprise
Waste	Hazard class	Code of waste	Meas. unit	Total	Method of disposal (utilization)
BAS, 1 Kollektornastr.					
Worn off, contaminated spoiled wiping materials.	3	7730.3. 1.0. 6	t/year	1.7	Agat-1 LLC
Motor oils and fluids, transmission, other spoiled or worn off materials	3	6000.2. 8.10	t/year	21.4	Agat-1 LLC
Unit of pumping stations "Pivnichnyy"23 Vvedenska Street					
Worn off, contaminated spoiled wiping materials.	3	7730.3. 1.0. 6	t/year	2,.36	Agat-1 LLC
Motor oils and fluids, transmission, other spoiled or worn off materials	3	6000.2. 8.10	t/year	7	Agat-1 LLC
Unit of pumping stations "Pivdenny" 90, Stolychne Shosse Street					
Luminiscent lamps, others	3	7710.3.	Units/year	2,628	Demikon LLC

contaning mercury which are broken or worked out		1.26			
Worn off, contaminated spoiled wiping materials.	3	7730.3. 1.0. 6	t/year	2	Agat-1 LLC
Motor oils and fluids, transmission, other spoiled or worn off materials	3	6000.2. 8.10	t/year	7	Agat-1 LLC

1 – analogous to the existing conditions (information on solid waste disposal)

No.	Name of measures	Haz. class	Waste formation, including		
			Unit	Total	Means of disposal (utilization)
2	Ash which is not caught by electro-filters		t/day	108.72	Transported out according to information of the Customer
3	Solid waste from flue gas treatment		t/day	8.64*	

- The solid waste of flue gas treatment must be placed in specially designated places that ensure protection from waste infiltration into the soil.
- Characteristics of sludge formed during treatment of wastewater from washing of automobiles, according to DSanPiN 2.2. 7.029-99

Name of waste	Hazard class of waste, content of chemical elements (compounds) in waste, %	Physical and chemical characteristics of waste (fire & explosive hazard, state of matter, solution, humidity)	Waste formed t/year incl.				
			Total	Transferred to other enterprises and organiz.	Used at other enterprises	Disposed	Landfilled
Sludge	**IV**. Ash content 11 %. Water content 80 %.	Solid, non-flammable substance, explosive, Practically insoluble, humidity - 80%, density -1.15 t/m^3	142.0	Transfer for disposal	-	-	-

- Characteristics of sludge formed during treatment of wastewater from washing of machinery and motors, and treated with bio-solution «Econadin», according to DSanPiN 2.2. 7.029-99

Name of waste	Hazard class of waste, content of chemical elements (compounds) in waste, %	Physical and chemical characteristics of waste (fire & explosive hazard, state of matter, solution, humidity)	Waste formed t/year incl.				
			Total	Transferred to other enterprises and organiz.	Used at other enterprises	Disposed	Landfilled
Sludge	**IV**. Ash content 11 %. Water content 80 %.	Solid, non-flammable substance, explosive, Practically insoluble, humidity - 80%, density -1.15 t/m^3	142.0	Transfer for disposal	-	-	-

Chemical component (compound) content in waste, %
Na_2CO_3 – 5.2;Na_2SO_4 – 5.4;Na_2SiO_3 – 2.0; NaCl – 0.5.
Mechanical additives (susp. solids)-20%, incl.
SiO_2 – 4.4 %; PO_4^{3-} – 3.25; SO_4^{2-} – 1.8; $CaSO_4$ – 0.8; $CaCO_3$ – 0.5; petroleum products-1.0; «Econadin» – 1.5.
Heavy metals, %:
Zn^{2+} – 0.5;Cu^{2+} – 0.05;Cr^{3+} – 0.05;Pb^{2+} – 0.04;Ni^{2+} – 0.04;Fe^{3+} – 0.02;Cd^{2+} – 0.005.

As a result of treatment of wastewater generated from washing of automobiles, sludge is formed in settling tanks and sludge thickeners, with the following properties: 80% water content, amount: 0.389 t/day, 142.0 t/year (considering sludge density of 1.15 t/m^3, this corresponds to 0.338 m^3/day, 123.5 m^3/year). The sludge is mixed with bio-additive "Econadin", using the ratio of 1:135 (800 l, or 105 kg), or at a 1:10 ratio compared to petroleum products (PP) (PP content in sludge before introduction of additive – 0.74 %, or 1050 kg, 105 kg «Econadin» is added per 1050 kg of PP).

As a result of treatment of wastewater generated from washing of machinery and motors, sludge is formed in settling tanks and sludge thickeners, with the following properties: 80% water content, amount: 0.01 t/day (once per week), 0.52 t/tear(considering sludge density of 1.15 t/m^3, this corresponds to 0.0087 m^3/day, 0.452 m^3/year).

The sludge is mixed with bio-additive "Econadin" using the ratio of 1:10 (50 l, or 6 kg), or at a 1:8.5 ratio compared to petroleum products (PP) (PP content in sludge before introduction of additive – 10.0 %, or 52 kg, 6 kg «Econadin» is added per 52 kg of PP).

11.4. Protective Measures During Construction

11.4.1. Air Pollution

Measures will be taken to prevent gas discharges into the atmosphere; open fires will not be allowed. During construction works utilizing machinery and mechanisms, the measures outlined in the design documents regarding fire and technical safety, as well as measures to prevent the formation of dust and air pollutants (according to the Law of Ukriane "On Protection of Atmospheric Air").

The heating of bitumen shall be carried out in special equipment. During the construction works, especially in the summer period, the construction site must be regularly rinsed with water.

11.4.2. Water

Toilets, showers and wash rooms are to be connected to the city sewer. All buildings are typical and mainly mobile with necessary engineering and sanitary equipment.

In the area of the construction sites, source which effects on the aquatic environment are washing the wheels of automobile transport at the exit, which are set to exclude pollution of roadway of the city streets in according with State Motor Vehicle Inspectorate of Ministry of Internal Affairs of Ukraine (letter dated 22.12.2000, № 10/4887) and allows for the construction of the project.

To prevent exposure to groundwater (at level rise above the expected bars) treatment facilities of deep under water type are designed with deployment in wells of composite reinforced concrete rings with the enhanced waterproofing.

11.4.3. Noise

The zone of construction and installation works must be separated by a fence. The noise impact is temporary. The width of the acoustic discomfort zone varies within the range of 15 to 100 meters. In case of complaints from the local residents, temporary noise screens will be used. The equipment which generates high levels of noise must be placed under covers and separated by walls/fences. It is recommended to carry out construction works during the day hours (7 AM – 11 PM). The construction site must be located as far from existing administrative buildings as possible.

11.4.4. Vibration

During construction, implementation of measures against vibration is extremely difficult. During construction, it is planned directly to use vibration-insulated and vibration-absorptive fence [GOST 12.4. 011-87]; individual protective measures from vibration [GOST 12.4. 002-74], automatic control, alarm and remote control [GOST 12.4. 011-87]. Enclosures limit access of people in an area with vibration impact. Structurally, the fence is made in the form of grid, net and opaque barriers made of metal, wood, concrete etc. Individual protective measures against vibrations are provided by GOST 12.4. 002-74. Vibroexcitation gloves and pads for vibration are used during working with manual machines. Vibroexcitation carpet in form of solid steel plate (thickness of 5 to 10mm) is used for vibration absorbing which impact on feet. This carpet is placed on Rabitz type steel-wire plaster fabric [Laptev et al. , 1990]. Remote control of construction equipment allows to exclude permanent human presence in the area of dangerous vibrations, creating favorable work conditions and to

ensure complete protection from vibration effects. therefore, this protection type is promising and should be widely used [Bortnytskyy, 1988].

The main measure against vibration is using the upgraded road equipment with modern vibration characteristics. Upgrading of road equipment by manufacturing plants includes: use of kinematic schemes without shock processes, processes with small accelerations, etc. : cam and crank mechanisms substitute for uniformly rotating or hydraulic; instead of straight tooth gears, use of gears with specific types of gearing (globoidal, herringbone), using vibration absorbing material (textolite, plastics). Manufacturing process should provide with high precision machining, careful balancing of parts and high quality machine assembly. Reducing vibration is effective in sources of its origin: reduction of forces exciting vibration (equilibration, construction improvements, increasing vibration frequency, optimization of internal forces and momentums) and decreasing of kinematic excitation of vibration (machine construction improvements, increased leveling capacity and support elements of self-propelled transport vehicles) and other measures of vibration reduction and self-excitation of vibration [Bortnytskyy, 1988].

Vibration isolation reduces the transmission of vibration to the body of the worker by entering spring connection with its source. Machines installed on a foundation with resilient spacers or on vibration isolating support. Vibration source isolated from its foundation by steel springs or pads with spring elements (rubber, cork, bituminous thick felt etc.). Springs are a universal tool of vibration isolation, and pads with spring-action material are well-isolated only against high frequency vibration. Methods of calculating the vibration isolation of structures and operators workplace of self-propelled machines are laid out in GOST 25575-82 and GOST 12.4. 093-80. there is constant improvement of amortizing seat elements by manufacturing plants [Chomiak, Skorchenko, 1983].

Vibro-immersion based on the transformation of the energy of mechanical oscillations (vibrations) to other forms of energy (mainly heat). Additionally, vibration is highly reduced, resonance modes are eliminated, vibration cushioning occurs. Vibration is absorbed through: use of construction materials with high internal friction; coating of spring-viscous materials layer on the product surface, which has high internal friction; including to the construction of additional absorbing element or coating that increases the active losses in the system; transformation of the mechanical oscillating energy into eddy current energy or electromagnetic fields [Bortnytskiy, 1988].

Absorbing vibration means to reduce the level of machinery vibration or mechanisms by using additional equipment. For example, equipment foundations are ensured reducing

critical amplitude of 0.1 - 0.2 mm. Vibration absorber of cars are air damping and spiral spring suspension. Dynamic absorbing of vibration is widely used. [Bortnytskiy, 1988].

In general, vibration impact on population, staff, soils and structural works is insignificant.

11.4.5. Protection from electromagnetic field during construction works

Methods of protection against electromagnetic fields (EMF): a decrease of intensity and density of power flux of EMF; screening of workplace; distance of workplace from the source of EMF; rational placing of the equipment that emits electromagnetic energy, rational operation modes of the equipment and staff; application of measures of safety alarm (light, sound, etc.), individual protective equipment [Bortnytskiy, 1988].

During construction works, it is necessary and sufficient standard (typical) measures to protect personnel from EMF.

11.4.6. Solid Waste

Table 11-4 shows the estimated volume of concrete wastes generated during the demolition of the existing facilities. The concrete wastes need to be transported and disposed at appropriate landfill sites. Metal scraps can be sold to scrap smelters. The details will be established by the environmental management plan during the detail design stage.

Table 11-4 Demolition Waste Generation Estimates

Facilities	Rehabilitation Scope	Construction Wastes	
		Concrete Waste (m^3)	Metal Scrap (t)
Block1 Wastewater Treatment	Whole	140,155	287
Block2 Wastewater Treatment	Whole	169,257	572
Block3 Wastewater Treatment	-	0	0
Aerobic Treatment Facilities	Whole	52,840	123
Anaerobic Facilities	Whole	20,495	276
Boilers	Whole	3,210	321
Block1 Pumps	Whole	8,429	0
Pozniaky P/S	Equipment	0	
Right-side P/S	—	0	0
Sludge P/S	Whole	866	87
Administration Facilities	Whole	2,109	211

Total		397,360	1,877

Source: JICA Study Team

11.4.7. Soil

It is planned complete biological reclamation of disturbed lands based on the plantation plan to be managed through the environmental management plan to be established.

The main measure to protect soil cover in the zone of construction impact is cutting and storing of rich soil with further reuse for landscaping.

11.4.8. Accidents

During construction, the use of typical composition of road-building machinery is necessary and sufficient. Lifting and transport mechanisms, their components, tools, safety devices, lifting bodies, removable lifting devices, containers, crane tracks and cradles must meet the "requirements of the construction rules and safe operation of cranes DNAOP 0.00-1.03-02, approved By the Order of the Ministry of Labor and Social Policy of Ukraine from 20.08.2002, № 409.

Electrical installations, electrical appliances must comply with "Regulations for Electrical Installation (REI).” Electrical installations include machinery and apparatus, auxiliary equipment, the rooms in which they are installed and which are intended for the production, transmission, transformation, energy distribution and transforming it into another form. REI are developed taking into consideration the mandatory maintenance of operation and routine preventive care testing and repair of electrical installations and their electrical and systematic preparation and testing service personnel in compliance with the applicable rules of technical operation and safety regulations.

11.4.9. Measures to create favorable living conditions for the population in the construction area.

The measures should aim to reduce the concentration of the negative impacts of nitrogen dioxide (NO_2) in the construction site area.

1. The limits of pollution sources in the construction site should pass no closer than 20 meters from the construction.
2. It is necessary, if possible, to increase the value for "length/width" of construction site (in the same area), which reduces the concentration of pollutants in residential buildings side walls by 20% to 80%.

3. Powerful machines and mechanisms that are the sources of NO_2 emissions, should be placed away from residential development.

Noise impact is temporary. the width of the zone of acoustic discomfort varies between 15m to 100 m. If necessary (there are complaints of the population) soundproofed temporary screens should be used.

11.5. Sanitary Protection Zone

(1) Sanitary Protection Zone Distance

The size of the Sanitary protection zone for industries and other facilities, which are the source of production hazards, must be set in accordance to present sanitary norms of their placements at confirmation of their adequacy according to "Methods of calculating concentrations in the ambient air of pollutants, contained in the emissions of enterprises" OND-86, calculations of noise levels and electro-magnetic radiation considering real sanitary situation (background contamination, peculiarities of relief, methodological conditions, wind rose and other), as well as data of laboratory research regarding similar operating enterprises and facilities.

On the external border of the Sanitary-protection zone, facing the residential area, concentration and levels of hazards must not exceed their sanitary norms (MPD, MPL), on the border of recreational zone – 0.8 from the normative value. The sanitary protection zone (SPZ) is established around the objects including wastewater treatment plant that are sources of discharge of pollutants, odor, elevated levels of noise, vibration, ultrasonic and electromagnetic waves, electronic fields, ionizing radiation, etc. for the purpose of separating objects from residential buildings by Order of the Ministry of Health of Ukraine No. 173, June 19, 1996. The distance of SPZ varies based on the scale of facility and category of industry. Within the SPZ, the construction of residential facilities, social infrastructure and other facilities related to the constant presence of people is prohibited. The value at the border of the SPZ should not exceed the hygienic standards established for the settlement area. The width of the SPZ depends on the nature and capacity, processes of unfavorable factors, wind rose, the use of gas and dust treatment devices, vibration and others.

Bortnychi station of aeration if designed for wastewater of up to 1800 thoudand. m^3/day and according to notice 2 table. 8.4 p. 8.12 DBN 360-92 ** for facilities of mechanical and biological treatment with sludge fields of capacity 500 thousand m^3/day an SPZ of 1200m is to be provided.

According to the letter from the Ministry of Health of Ukraine № 05.01.03-45 of 18.01.2007 and № 05.03.02-07/36985 of 23.07.07 BAS is required to have the SPZ on distance of 600m from secondary sedimentation tanks and distance 900m from primary sedimentation tanks of Block 1 considering reconstruction of BAS.

The facilities were established prior to enactment of the regulation in 1964 where the original Bortnych Village existed in a small scale. Since then population and subsequent residential development continued to surround the premised of BAS. The new buffering distance will be determined after the approval of the new processes and rehabilitation of the BAS proposed herein by the Ministry of Nature in consultation with the State Expertise Committee.

(2) Minimal Distance to Parking Lots

Minimal distances from windows of residential and public buildings as well as from borders of areas of schools, kindergartens and hospitals, to the walls of garage or borders of open parking must be predicted by Table 11-5[table. 7.5 p. 7.50 DBN 360-92; p. 5.28 and ap. 10 DSP 173-96]. For garages of capacity of more than 10 cars, distances provided in table, are taken as interpolation [p. 7.51 DBN 360-92]. Distances can be shortened by 25 % at the absence in garages of I-II degree of fire resistance of windows, that can be opened, and entrances, oriented into the side of residential and public houses. [app. 10 DSP 173-96].

Table 11-5 Minimal distances (sanitary distances, m) from borders of areas of ground and combined ground-underground garages, and car parks for residential and public houses of I-IV stage of fire resistance.

Constructions [Table. 7.5 п. 7.50 DBN 360-92; app. 10 DSP 173-96]	**Fire-resistance**	**Number of passenger cars**				
		≤ 10	11 -50	51 -100	101 -300	> 300
public houses	I-II	10	10	15	25	25
residential houses - woodblocks without windows	I-II	10	15	25	35	50
		10	10	15	25	35
Buildings [Table. 6.8 p. 6.53 DBN Б. 2.4-1-94]		Number of passenger cars				
		≤ 10		11 – 50		51 – 100
residential buildings		15		15		25

Normative distance from guest parking lots to the windows of administrative and operating facilities – 15m. Normative distance is kept.

11.6. Emergency situations

The technological part of the project provides measures of emergency and performance safety of technological operations. In conditions of compliance with safety rules, including fire safety, emergency situations are not expected. The company provides creation of the standard unit responsible for compliance in manufacturing safety equipment (safety engineer).
the company management is responsible for the safety and labor protection required to prevent accidents at work, and if they occur immediately take all necessary measures to rescue people, eliminate accidents and their consequences in accordance with the requirements of laws and regulations.

12. ENVIRONMENTAL MONITORING PROGRAM

12.1. Institutional Setup

The basic responsibilities of pollutant emission monitoring are the domain of KVK and its laboratories. The laboratory should be equipped and staffed appropriately to undertake regular measurements of water, solids and air at specified intervals with proper methods. On the other hand, higher ranked institutions. The Ministry of Nature is responsible for the compliance to the preservation of environment and the Ministry of Health must oversee public hygiene including the compliance of Sanitary Protection Zone.
The share of responsibilities will be as follows:

Flue gas: regular monitoring by BAS Laboratory

Ambient air: inspection on the boundaries of SPZ by Darnytsia District Sanitary & Epidemiological Service of Ministry of Health as well as Environmental Inspections of Ministry of Nature for monitoring at the emissions point, and SPZ boundaries.

Effluent Water: regular monitoring by BAS Lab, and inspection of BAS compliance by Darnytsia District Sanitary & Epidemiological Service of Dnipro Basin Department of the State Water Resources Agency of Ukraine

Groundwater: regular monitoring by BAS Laboratory and inspection by Darnytsia District Sanitary & Epidemiological Service

Ashes and other solid wastes: regular monitoring by BAS Laboratory and inspection by Darnytsia District Sanitary & Epidemiological Service.

12.1.1. Atmospheric Air Quality Monitoring

The quality of atmospheric air of Kyiv is controlled by the municipal sanitary inspector regularly (four times per year).

The measurements of the quantity of pollutant emissions from mechanical and boiler equipment are carried out in their emission points into the atmosphere. The sampling points and selected based on the "Typical instruction regarding organization of industrial emissions control systems in various industries", Leningrad, 1996. The control of the content and quality of the atmospheric emissions needs to be carried out by means of periodic industrial control, as well as using an express-method, to be carried out every month.

12.1.2. Water Quality Monitoring

Water quality in the river Dnipro at the effluent discharge point is analyzed by KVK regularly (once/month from March to October). Quality is controlled in 10 different locations: the right bank, the height, the left bank and discharge point, 500m upstream and 500m downstream and in the channel.

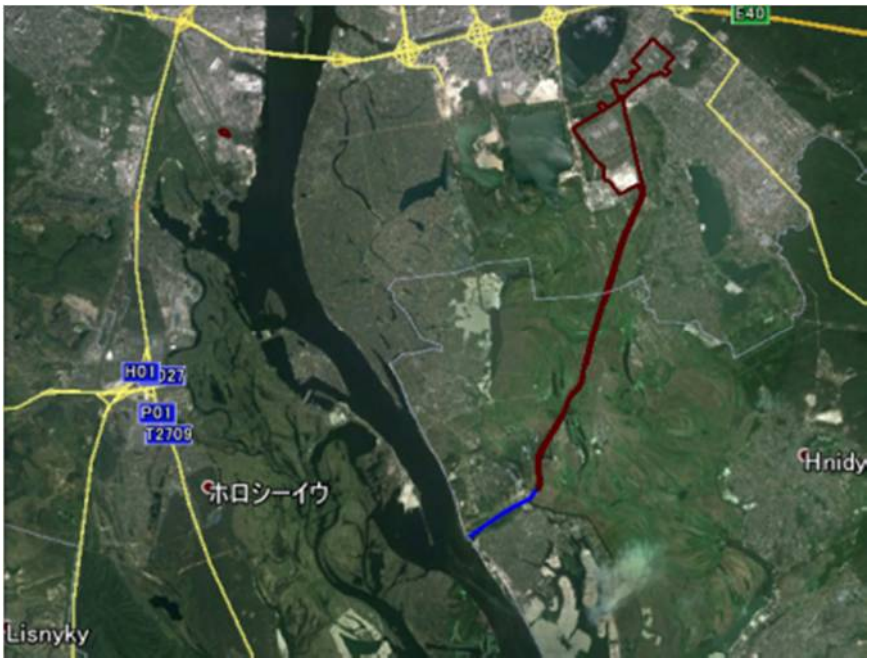

Fig. 12-1. Location of water quality monitoring points of the river Dnipro.

The results of the water quality of the river Dnipro at the confluence and the standards that must be followed, are listed in the following table.

Table 12-1. The results of the annual water quality tests and water quality standards

№	Indicator	Quality of river water		Standards	
		mg/l	g/hour	mg/l	g/hour
1	Ammonia nitrogen	1.6	56,920.3	2.00	150,000.0

№	Indicator	Quality of river water		Standards	
		mg/l	g/hour	mg/l	g/hour
2	BOD_5	2.50	88,937.9	4.5	337,500.0
3	Suspended solids	8.2	291,716.3	10.0	750,000.0
4	Iron	0.46	16,364.6	0.46	34,500.0
5	Mineralization	430.0	15,297,318.8	430.0	32,250,000.0
6	Petroleum products	0.2	7,115.0	0.20	15,000.0
7	Nitrites	5.27	187,481.1	5.27	395,250.0
8	Nitrates	0.67	23,835.5	0.67	50,250.0
9	Synthetic surface active substances (anion) (synthetic)	0.1	3,557.5	0.10	7,500.0
10	Sulfates	48.2	1,714,722.0	50.0	3,750,000.0
11	Phosphates	1.6	56,920.3	1.6	120,000.0
12	Chlorides	46.9	1,668,475.0	50.0	3,750,000.0
13	COD (chemical oxygen demand)	48.1	1,711,165.2	48.1	3,607,500.0

Analysis of samples of water and sludge should be carried out using the latest multi-element methods (ISP-AES, ISP-MS, etc.).

12.1.3. Solid Waste Monitoring

KVK must organize the monitoring of sewage treatment process, as well as proper removal of:

- Sludge from screening department generated during primary treatment;
- Sludge from sedimentation tanks;
- Ashes formed during the incineration of sludge.

The control over the compliance with the regulations at the company is carried out for sources of solid waste formation – according to tables of formation and disposal of solid waste (which are approved by the company according to the current legislation). This control is performed by the bodies of environmental inspection and sanitary and epidemiological inspection. Both continuous and periodical monitoring of solid waste is used.

The chemical and bacteriological laboratory at BSA shall provide full and timely chemical analysis of ash.

12.2. Proposals of Normal Maximum Permissible Emission

According to the order of Ministry of Nature of Ukraine from 09.03.2006 № 108 "On approval of the Instruction on general requirements to the documentation, in which grounded are emissions volumes, for receiving the permission for emissions of pollutants into the atmosphere by stationary sources of enterprises, institutions, organizations and private persons

entrepreneurs" for receiving permits to created new stationary sources must provide norms of maximum permissible emissions (MPE) from the stationary sources.

A proposal for norms of MPE from the stationary sources is provided in Appendix D: Proposed Maximum Allowable Emission in Atmosphere.

12.3. Air Quality Monitoring

(1) Ambient Air Quality Monitoring

The monitoring specification for the ambient air are shown in Table 12-2 mainly to comply with the standards. The methods and corresponding facilities need to be incorporated according to the requirements of frequency and accuracy of measurements for the set targets and expected concentrations.

Table 12-2. Ambient Air Quality Monitoring

Item	Unit	Frequency	Local Standards Half-hour one time maximum	EU Standards *
CO	mg/m^3	monthly	5.0	10*[1]
SO_2	mg/m^3	monthly	0.50	0.35 (24) *[2] 0.125(3) *[3]
NO_2	mg/m^3	monthly	0.2	0.2 (18)*[2] 0.04*[4]
NH_3	mg/m^3	monthly	0.2	-
H_2S	mg/m^3	monthly	0.008	-
Particulate matter(PM_{10})	$\mu g/m^3$	monthly	-	50(35) *[3] 40*[4]

Notes: * DIRECTIVE 2008/50/EC
*1 one day 8 hour mean value
*2 one hour value, the value in parenthesis indicates the number of times not to be exceeded per a calendar year
*3 one day mean, the value in parenthesis indicates t the number of times not to be exceeded per a calendar year
*4 one calendar year mean

(2) Flue Gas Monitoring

The monitoring specification for the flue gas from the incinerators are shown in Table 12-3 mainly to comply with the emission standards as well as to monitor the performance of incinerations. O_2 and CO_2 are required for the latter purpose. The frequencies defined for the priority of measurements. The methods and corresponding designs need to be incorporated

according to the requirements of frequency and accuracy of measurements for the set targets and expected concentrations.

Table 12-3 Flue Gas from the Incinerator

Item	Unit	Frequency	Referred International Standards* Upper: daily average Lower: half-hourly average	Regulation on Maximum Permissible Emission pursuant to Order of Ministry of Nature No. 309 of 27.07.2006
NO_x	mg/Nm^3	Continuous	200 400	500
CO	mg/Nm^3	Continuous	50 150*[1] 100*[2]	250
O_2**	mg/Nm^3	Continuous		
CO_2**	mg/Nm^3	Continuous		
SO_2	mg/Nm^3	Continuous	50 200	Not regulated
Total dust	mg/Nm^3	Continuous	10 30	150
TOC	mg/Nm^3	1 time/month	10 20	Not regulated
HCL	mg/Nm^3	1 time/month	10 60	Not regulated
HF	mg/Nm^3	1 time/month	1 4	5
Cd	mg/Nm^3	1 time/month	0.05*[3]	0.2
Tl	mg/Nm^3	1 time/month		0.2
Hg	mg/Nm^3	1 time/month	0.05*[3]	0.2
Sb	mg/Nm^3	2 time/year	0.5*[3]	0.2
As	mg/Nm^3	2 time/year		
Pb	mg/Nm^3	2 time/year		
Cr	mg/Nm^3	2 time/year		
Co	mg/Nm^3	2 time/year		
Cu	mg/Nm^3	2 time/year		
Mn	mg/Nm^3	2 time/year		
Ni	mg/Nm^3	2 time/year		
V	mg/Nm^3	2 time/year		

*Directive 2000/76/EC on the incineration of waste
*1: At least 95 % of all measurements determined as 10-minute average values
*2: all measurements determined as half-hourly average values taken in any 24 hour period.□

*3: Average values over the sample period of a minimum of 30 minutes and a maximum of 8 hours

12.4. Monitoring Quality of Aquatic environment

KVK is now undertaking regular monitoring of water on Dnipro River, sewerage influent, intermediate processed water and final effluent.

(1) Dnipro River Water Monitoring

Table 12-4 shows the monitoring specifications for the monitoring of Dnipro River to comply with the natural surface water standards. The frequencies defined for the priority of measurements. The methods and corresponding designs need to be incorporated according to the requirements of frequency and accuracy of measurements for the set targets and expected concentrations.

Table 12-4 Water quality Monitoring of Dnipro River

Item	Unit	Frequency	Country's Standards*	Referred International Standards**
Temperature	°C	4 times/year	-	-
Transparency	cm	4 times/year	25	-
pH	-	4 times/year	6.5-8.5	6.5-8.5
BOD_5	mg/l	4 times/year	4.5	2.0
DO	mg/l	4 times/year	4	7.5
Ammonium Nitrogen	mg/l	4 times/year	1	-
Nitrite Nitrogen	mg/l	4 times/year	0.67	-
Nitrate Nitrogen	mg/l	4 times/year	5.27	-
Phosphorus-T	mg/l	4 times/year	1.6	-
E.Coliform	Unit/100 ml	4 times/year	1,000	1,000

(2) Sewerage Influent Monitoring

Table 12-5 shows the monitoring specifications for sewage influent to ensure effective and efficient treatment operations. The frequencies defined for the priority of measurements. The methods and corresponding designs need to be incorporated according to the requirements of frequency and accuracy of measurements for the set targets and expected concentrations.

Table 12-5 Monitoring of Sewage Influent

Item	Unit	Frequency
SS	mg/l	1 time/week
Temperature	°C	1 time/week
Transparency	Cm	1 time/week
pH		1 time/week
BOD_5	mg/l	1 time/week
COD	mg/l	1 time/week
Sulfates	mg/l	1 time/week
Chlorides	mg/l	1 time/week
Ammonia nitrogen	mg/l	1 time/week
Nitrites	mg/l	1 time/week
Nitrates	mg/l	1 time/week
Total Nitrogen	mg/l	1 time/week
DO	mg/l	1 time/week
Cl	mg/Nm^3	1 time/month
F	mg/Nm^3	1 time/month
Cd	mg/Nm^3	1 time/month
Hg	mg/Nm^3	1 time/month
As	mg/Nm^3	2 time/year
Pb	mg/Nm^3	2 time/year
Cr	mg/Nm^3	2 time/year
Cu	mg/Nm^3	2 time/year
Mn	mg/Nm^3	2 time/year

(3) Sewage Effluent Monitoring

Table 12-6 shows the monitoring specifications for the monitoring of sewerage effluent to comply with the natural surface water standards. The frequencies defined for the priority of measurements. The methods and corresponding designs need to be incorporated according to the requirements of frequency and accuracy of measurements for the set targets and expected concentrations.

Table 12-6 Monitoring of Sewerage Effluent

Item	Unit	Frequenc y	Project Standards*	EU Directives (91/27/EEC)Standards
SS	mg/l	1 time/week	15.00	35.00
BOD_5	mg/l	1 time/week	15.00	25.00
COD	mg/l	1 time/week	80.00	125.00
Total nitrogen	mg/l	1 time/week	10.00	10.00
Total phosphorus	mg/l	1 time/week	1.00	1.00
Sulfates	Mg/l	1 time/week	120	
DO	mg/l	1 time/week	4.00	-
CL	mg/l	1 time/month	TBD	
F	mg/l	1 time/month	8	
Cd	mg/l	1 time/month	0.1	
Hg	mg/l	1 time/month	0.005	
As	mg/l	2 time/year	0.1	
Pb	mg/l	2 time/year	0.1	
Cr6＋	mg/l	2 time/year	0.5	
Cr	mg/l	2 time/year	2	

Note: * the standards for heavy metals and petroleum products need to be decided. The figures indicate the standards adopted in Japan.

12.5. Groundwater monitoring

Monitoring wells will be created to prevent pollution of groundwater due to breaches of hydroisolation of BSA wastewater treatment facilities. The indicators are analogous to Table 12-6. Monitoring frequency shall be once every six months.

12.6. Monitoring of Solid Waste

(1) Monitoring of Sludge

The monitoring specification for the sludge to the incinerators are shown in Table 12-7 mainly to ensure effective and efficient operations as well as to maintain compliance with air pollutant emissions with varying feed qualities. The frequencies defined for the priority of measurements. The methods and corresponding designs need to be incorporated according to the requirements of frequency and accuracy of measurements for the set targets and expected concentrations.

Table 12-7 Monitoring of Sludge Composition

Item	Unit	Frequency

Dry Substance	g/kg	1 time/week
Water	%	1 time/week
Volatile Substance	g/kg	1 time/week
Heat Value	kcal/kg	1 time/week
Cl-T	mg/kg	1 time/month
TOC	mg/kg	1 time/month
Total Nitrogen	mg/kg	1 time/month
Sulfates	mg/kg	1 time/month
Hg	mg/kg	1 time/month
Cd	mg/kg	1 time/month
Pb	mg/kg	1 time/month
Cd	mg/kg	2 time/year
Tl	mg/kg	2 time/year
As	mg/kg	2 time/year
Cr	mg/kg	2 time/year
Sb	mg/kg	2 time/year
Mn	mg/kg	2 time/year
Ni	mg/kg	2 time/year
V	mg/kg	2 time/year

(2) **Ash Monitoring**

The monitoring specification for the ashes from the incinerators are shown in Table 12-8 mainly to comply with the emission standards as well as to monitor the quality of ashes for recycling. There are some substances such as chlorine, fluorine, chromium that may affect the quality of cements etc. Thus some quality control will be required from the receiving manufacturers. The frequencies defined for the priority of measurements. The methods and corresponding designs need to be incorporated according to the requirements of frequency and accuracy of measurements for the set targets and expected concentrations.

Table 12-8 Ashes

Item	Unit	Frequency
SiO_2	%	2times/year
Al_2O_3	%	2times/year
FeO_2	%	2times/year
CaO	%	2times/year
MnO	%	2times/year
Na_2O	%	2times/year
K_2O	%	2times/year
TiO_2	%	2times/year

P_2O_5	%	2times/year
Cl-	%	2times/year
F	mg/kg	2times/year
Volatile Substance	mg/kg	2times/year
Hg	mg/kg	2times/year
Cr	mg/kg	2times/year
Cr^6+	mg/kg	2times/year
Cd	mg/kg	2times/year
As	mg/kg	2times/year
Pb	mg/kg	2times/year

12.7. Construction Stage Monitoring

The construction stage monitoring will be developed with the environmental management plan which must be developed during the stage of the detail design period.

The following parameters must be used to monitor the effectiveness of wastewater treatment:

(1) Noise and Vibration

The monitoring specification for noise from construction activities are shown in Table 12-9 mainly to comply with the emission standards. The location should be selected at the closest residential area to the BAS. The methods and corresponding designs need to be incorporated according to the requirements of frequency and accuracy of measurements for the set targets.

Table 12-9 Noise at the Border of SPZ

Item	Unit	Frequency	Country's Standards	Referred International Standards**
Noise level	dB	continuous	65* 80**	70

* Maximum allowable level eq. day

** Maximum allowable level max. day

*** IFC General Health, and Safety (EHS) Guidelines, April 2007

(2) Solid Waste

The quantity and disposal methods for the wastes generated from demolition of existing facilities must be recorded for transport and disposal at proper locations according to the environmental management plan to be established.

(3) **Groundwater**

Groundwater level: 2-3 bore wells must be maintained to monitor the groundwater level to ensure that there is no impact from construction activities. Sample of ground water should be taken for the monitoring of water quality and impacts from construction activities.