SFG1198 REV

REPUBLIC OF UZBEKISTAN

District Heating Energy Efficiency Project

ENVIRONMENTAL IMPACT ASSESSMENT
&
ENVIRONMENTAL MANAGMENT PLAN

Tashkent, September 13, 2017

Content

ABBREVIATIONS AND ACRONYMS

CHP	Combined Heat and Power plant
DH	District heating
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ES	Environmental Specialist
GHS	Group Heating Substation
IHS	Individual Heating Substation
MAL	Maximum Allowable Limit
ME	Ministry of Economics
NGO	Non-Governmental Organization
O&M	Operation and Maintenance
OP	Operation Policy (of the World Bank)
OHS	Occupational Health and Safety
OP/BP	Operational Policies, Bank Procedures
PCU	Project Coordination Unit
PIU	Project Implementation Unit
RUZ	Republic of Uzbekistan
SEE	State Ecological Expertise
SEI	State Ecological Inspectorate
TOR	Terms of Reference
USD	United States Dollar
UZS	Uzbekistan Sum
WB	World Bank
WHO	World Health Organization

EXECUTIVE SUMMARY

1. *Project objective and proposed investments.* The project development objective is to improve the efficiency and quality of heating and hot water services in selected cities of Uzbekistan. The objective will be achieved through rehabilitation and renovation of heating and hot water systems on the supply side and energy efficiency on the demand (building level) side. The cities were selected by Government and will serve as pilots to be replicated throughout the country. The Project would be implemented over five years and co-financed by an Investment Project Financing (PIF), supported by a $140 million IDA credit to the government of Uzbekistan that will on-lend the credit and loan proceeds to the five participating cities.

The Project has three following components:

Component 1: Modernization of DH Systems. The component will finance energy efficiency investments in renovation of heat production and transmission and distribution systems, including installation of building-level IHS and heat meters for billing purposes. Also, gas, electricity, and water supply systems will be upgraded, where it is needed for DH purposes. In addition to DH infrastructure, the component will finance procurement of specialized maintenance equipment for the participating heating utilities. The total amount is expected to be of $201 million including financing by the IDA credit of 140 million and $50 million IBRD loan for Sergeli District of Tashkent City.

The technical solutions would differ depending on the local conditions at Project areas, but the overall approach would be common for all cities - switching from the open heat and hot water supply system to the closed one. The supply side investments would range from rehabilitation of the existing DH production, distribution networks, and installation of individual heat substations in the Sergili District of Tashkent and Chirchick (the exact number and their location will be known later, but generally all of them will be located in the apartment blocks basements), istallation of two new gas-fired boilers in Samarkand and Bukhara, to total rebuilding of the DH system in Andijan, where DH services virtually ceased to exist several years ago.

The proposed investments in Andijan would include the following: (a) Reconstruction of the existing boilerhouses (increase of efficiency by 90%), construction of new heat production facilities and closure of BHs. After the rehabilitation program the production facilities would consist of 2 central BHs, 8 local BHs and 47 mini (container) boilerhouses; (b) Network replacement (about 60% of the existing network); (c) Change from an open system to a closed system; (d) Installation of IHSs in all buildings connected to the DH network. The IHSs shall be equipped with heat meters and all residential apartment buildings will also be equipped with heat meters; (e) Change from a vertical piping system to a horizontal piping system inside residential buildings; and (f) Replacement of all hot water and heating piping inside residential apartment buildings. Rehabilitation of the DH system in Chirchik will include renovation of the generation capacities, the networks and installation of the IHSs with change from the open system to a closed system and installation of the mini-CHPs at boilerhouses; and possibly installation of solar water heaters in the ITPs. Lastly, the investments in Tashkent Sergelli district will include mostly replacement of old pipes, installation of IHSs, of solar pannels and replacement of pumps. The project investments for Bukhara will include the following: (a) installation of two new gas-fired boilers with total capacity of 75 MW; (b) replacement of about 11.5 km (trench length) of DH network;(c) installation of 408 IHS to

serve residential and public buildings connected to the DH system; (d) electricity distribution network partial reconstruction; and (e) maintenance equipment, tools, and vehicles for the BEM and and Bukhara Issiklik Manbai (BIM) district heating companies. The project investments for Samarkand will include the following: (a) installation of two new gas-fired boilers with total capacity of 85 MW; (b) replacement of about 22.5 km (trench length) of DH network; (c) installation of 346 IHS to serve residential and public buildings connected to the DH system; (e) electricity distribution network partial reconstruction; and (d) maintenance equipment, tools, and vehicles for the DHC. The project doesn't suppose the installation of transformers in existing transformer substations and are not going to replace any old transformers. So, ther is ne necessity in the removal of old transformers.

Component 2: Rehabilitation of In-building DH Infrastructure and Energy Efficiency Improvements. This component will finance replacement of in-building heat distribution pipelines and radiators, as well as pilot implementation of cost-effective energy efficiency measures (introducing the sealing on entrance doors, roof hatch, seismic joints, and so on) in 15 selected residential buildings and 10 social facilities. The pilot shall be financed from proceeds of the Bank credit. The tenants via annual contributions to the HOA will finance the investments in MABs. The administration of the participating cities developed financing mechanisms to help vulnerable households bear the upfront financing cost of investments in in-building DH infrastructure and energy efficiency measures. The investments in public buildings will be funded by the respective city administrations. In Andijan, where DH has not been available for a number of years, in-house heating infrastructure will need to be replaced in all the residential and public buildings to be connected to the project supported heat supply system. In Chirchik, in-house heating infrastructure will most probably be completed by the time of the project start. In Sergeli district of Tashkent the internal piping in buildings has been in operation, but over time it will need to be gradually replaced. In Bukhara city practically all buildings in the project area have already new plastic pipes for heat and hot water distribution inside the buildings. In Samarkand city all in-building pipes should be gradually replaced in the project area.

Component 3: Implementation support. This component will finance capacity-building and implementation support for the Project Coordination Unit (PCU) in the Kommunkhizmat Agency of the Ministry of Housing and Communal Services, participating heating utilities and their Project Implementation Units (PIUs), and home owner’s associations of the MABs and their management companies, including the following sub-components: (a) design and supervision consultancy to support the PCU and PIUs at the heating utilities in implementing and supervising the project. This will include preparation of the bidding documents and technical specifications for the project starting from the second year of implementation. The first year bidding documents and technical specifications will be prepared under the ECAPDEV grant; (b) training and capacity building, including study tours for the five DH utilities, as well as knowledge-sharing and project results dissemination workshops; (c) development of tariff and consumption-based billing methodologies, including workshops for DH utilities and other stakeholders; (d) social surveys of customer satisfaction in the five participating cities at midterm and before the project closing, with disaggregation by gender; (e) annual financial audit of the project accounts over the project lifetime; (f) development of communication strategy and action plan for public information campaign for the five DHCs and support in its implementation; and (g) other consultancy services identified during project implementation.

2. *Project Location.* The project will be in the following localities: Andijan City (Andijan oblast), Chirchick city (Tashkent oblast), Samarkand (Samakand oblast), Bukhara (Bukhara oblast) and Tashkent City (its Sergili district). The specific project sites will be selected after the feasibility studies are completed; as specified above they are expected to include renovation and replacement of pipeline routes, boiler houses, and individual heat substations in building basements, and pipes and radiators inside apartments.

3. *Potential impacts and project category.* Conducted project EIA concluded it will generate mostly positive socio-economic benefits due to the improvement of population hot water supply and heating services along with improved environmental conditions on the involved cities. Replacement and modernization of old inefficient boilers or installation of new ones will significantly reduce the level of pollutants emissions which will have significant effects on the health of population. At the same time, it might also generate a series of adverse impacts: noise; air pollution; impact on water quality and resources; impact on water by the construction run-offs; disturbance of traffic during construction and rehabilitation works; construction dust; and worker's safety, etc. However, these impacts will be temporary and site specific and could be easily mitigated through implementing adequate avoidance and/or mitigation measures. It was also concluded no impacts are expected on sensitive or protected areas. Furthermore, no any physical cultural resources will be involved/or impacted. Taking into consideration the character of potential impacts the project was assigned as Category B for which it is necessary to conduct an EIA and prepare, for each of the included in the project city, a separate Environmental Management Plan (EMP).

4. *Purpose of the EA.* The objective of the project Environmental Impact Assessment (EIA) and EMPs was to analyze the potential adverse environmental issues related to the proposed activities and to ensure that these aspects will be adequately addressed and mitigated during the project implementation in full compliance with WB requirements and National legislation. Along with the necessary mitigation measures the EA report should also contain relevant monitoring and reporting activities as well as EMPs implementing arrangements.

5. *The EA report provisions.* The EA report along with the WB safeguards policies applied to the current project and description of the policies, legal, and administrative framework regarding environmental management and the centralized heating sector in place in Uzbekistan includes also five site specific EIA&EMPs for participating cities (Andijan, Bukhara, Chirchik, Samarkand and Sergili district of Tashkent city). The EIA&EMP reports contains the following: (a) baseline analysis; (b) project alternatives; (c) potential environmental impacts and necessary activities targeted at mitigating them; (d) monitoring plan for EMPs implementation; (e) EMPs implementing arrangements as well as a short analysis of District Heating Companies' EA capacity and needed training in this regard.

6. *EIA&EMP approval by the SEE.* All five EMPs for participating cities have been officially reviewed and approved by the Oblasts State Ecological Expertise. The obtained approvals contain also a series of conditions to be fulfilled during the project implementation.

7. *Environmental mitigation measures.* The EMPs stipulate all adverse environmental impacts associated with the Project will be prevented, eliminated, or minimized to an acceptable level. This will be achieved through the implementation of the EMPs' environmental mitigation measures, including careful replacing of old pipes and pumps and conducting rehabilitation works in a way that would prevent as much as possible cutting of

trees, destroying of landscape in parks, pollution of air and soil; preventing noise pollution; ensuring labor safety and health impacts during boilers replacement or modernizing, welding operations etc.

8. *Environmental supervision and monitoring.* Environmental supervision and monitoring during project implementation will provide information about the project environmental impacts and the effectiveness of applied mitigation measures. Such information enables the client and the Bank to evaluate the success of mitigation as part of project supervision, and allows corrective action to be taken when needed. The monitoring section of the EMPs provides: (a) details, of monitoring measures, including the parameters to be measured, methods to be used, sampling locations, frequency of measurements; and, (b) monitoring and reporting procedures to (i) ensure early detection of conditions that necessitate particular mitigation measures, and (ii) furnish information on the progress and results of mitigation; and (c) institutional responsibilities and grievance mechanism.

9. *Reporting.* Supervision of the EMPs implementation will be the responsibility of the DH enterprises which periodically (as per monitoring schedule) will prepare short reports on EMPs implementation to be submitted to the PCU. PCU will compile these reports and semi-annually will present short information about the EMP implementation as part of the Progress Reports to the WB.

10. *Integration of the EMPs into project documents*. The EMP provisions will form part of the design documents for the project, and will be included in construction contracts for proposed activities, both into specifications and bills of quantities. Respectively the Contractors will be required to include the cost of EMP requirements in their financial bids and required to comply with them while implementing the project activities. The bidding documents for selecting the contractors will include specifications that would ensure effective implementation of environmental, health and safety performance criteria by the winning bidder and in particular: (i) preventing/limiting disturbance of soils and vegetation removal to the minimum; prevent soil compaction as well as other potential impacts; (ii) ensuring that all ground disturbing activities are conducted consistent with the construction requirements; (iii) developing a traffic management plan that include measures to ensure work zone safety for construction workers and the travelling public; (iv) conducting all activities on installing new boilers will be done with due care, ensuring labor safety; and (iv) the traffic management plan should be approved by the Traffic Police prior to commence of any construction/repair works; etc. The contract with winning bidder will include necessary also an obligation to inform the DH companies of any significant HSE accidents and events among subcontracted project workers.

11. *Implementing arrangements.* While overall the project implementation responsibility will lie with the central PCU, created under the Kommunkhizmat Agency, the safeguards issues will be mostly under the responsibility of participating utility companies. The central PCU will have an ES which will oversee overall coordination of individual EMPs implementation, reporting to the Agency and to the WB regarding safeguards issues, as well as of integrating safeguards requirements into biding and contracting documents. He/she also will be responsible for interaction with the environmental authorities, ensuring an efficient implementation of safeguards documents and will undertake, randomly, field visits and environmental supervision and monitoring, assessing environmental compliance at worksites, advising project participants and utilities ES on environmental issues. The PCU ES will be, also, responsible for identifying EA training needs for the participating district heating

companies and its ESs, and analyzing contracts in terms of environmental management and mitigation issues. The PIUs to be created in all five cities, would also include an ES, who might be the existing staff of the utility, responsible for Environment, Health and Safety, or, a new staff, hired for this purpose. His/her main duties would be to ensure that the project activities are implemented in compliance with the WB and national EA rules and procedures. Among major responsibilities of the PIU environmental safeguards specialist will be the following: (a) ensuring that contractors complies with all EMPs requirements; (b) coordinating of all environmental and EA related issues at the city and oblast level; (c) conducting EMP supervision and monitoring and assessing environmental impacts and efficiency of mitigation measures, as well as identifying non-compliance issues or adverse trends in results, and putting in place programs to correct any identified problems; (d) when needed, providing advises and consulting contractors in EMP implementation; and, (e) reporting to the PCU with regard to EMP implementation. As the DH companies lack experience in implementing environmental safeguards, the project will provide capacity building in this area. For this purpose, before the civil works will start, the client will hire a consultant which will provide EA training which will include also training on ISO 14000 (Environmental Management) and ISO 18000 (Health and Labor Safety). This activity will continue also during the project implementation when the consultant will provide on the job training regarding environmental monitoring and supervision.

12. *Contractors' responsibilities.* The actual investments will be carried out by contractors selected through the public tendering process. They should operate in full compliance with national environmental legislation and with the EMPs requirements. Further, the contractors are obliged to follow regulative requirements of the national law related to traffic safety, occupational health and safety; fire safety; environmental protection; and community health and safety. All EMPs' associated activities will be financed by the contractors. The contractors will also be requested to designate a person in charge of environmental, health and safety issues and for implementing the EMP.

13. *Public consultation and information disclosure.* The draft EIA&EMPs report was disclosed and consulted in all participating cities. The final version of the document (in English and Russian) was posted on the Ministry of Housing and Communal Services website and submitted to the World Bank for its disclosure on its external website. The EMPs will be used by the PCU and district Heating Companies during the project implementation.

1. PROJECT BACKGROUND

1.1. Project development objective

The project development objective is to improve the efficiency and quality of heating and hot water services in selected cities of Uzbekistan. The objective will be achieved through rehabilitation and renovation of heating and hot water systems on the supply side and energy efficiency on the demand (building level) side. The cities were selected by Government and will serve as pilots to be replicated throughout the country. The Project would be implemented over five years and co-financed by an Investment Project Financing (IPF), supported by a $140 million IDA credit to the government of Uzbekistan that will on-lend the credit and loan proceeds to the five participating cities.

1.2. Proposed investments

The Project has three following components:

Component 1: Supply Side Investments. This Component would support investments in renovation of heating generation and distribution and hot water production in the five pilot cities. The technical solutions would differ depending on the local conditions at Project areas, but the overall approach would be common for all five cities - switching from the open heat and hot water supply system to the closed one. The supply side investments would range from rehabilitation of the existing DH production, distribution networks, and installation of individual heat substations in the Sergili District of Tashkent and Chirchick (the exact number and their location will be known later, but generally all of them will be located in the apartment blocks basements), installation of two new gas-fired boilers in Samarkand and Bukhara to total rebuilding of the DH system in Andijan, where DH services virtually ceased to exist several years ago. The feasibility studies to detail investments will be prepared by the Uzbek counterparts throughout 2014, supported by an ECADEV Project Preparation Grant of US$700k that has been already approved by the Grant authorities.

The proposed investments in Andijan would include the following: (a) Reconstruction of the existing boilerhouses (increase of efficiency by 90%), construction of new heat production facilities and closure of BHs. After the rehabilitation program the production facilities would consist of 2 central BHs, 8 local BHs and 47 mini (container) boilerhouses; (b) Network replacement (about 60% of the existing network); (c) Change from an open system to a closed system; (d) Installation of IHSs in all buildings connected to the DH network. The IHSs shall be equipped with heat meters and all residential apartment buildings will also be equipped with heat meters; (e) Change from a vertical piping system to a horizontal piping system inside residential buildings; and (f) Replacement of all hot water and heating piping inside residential apartment buildings. The rehabilitation of the DH system in Chirchik will include renovation of the generation capacities, the networks and installation of the IHSs with change from the open system to a closed system and installation of the mini-CHPs at boiler houses; and possibly installation of solar water heaters in the ITPs. Lastly, the investments in Tashkent Sergelli district would include replacement of pipes, pumps and installation of IHSs and of solar pannels. The project investments for Bukhara will include the following: (a) installation of two new gas-fired boilers with total capacity of 75 MW; (b) replacement of about 11.5 km (trench length) of DH network;(c) installation of 408 IHS to serve residential

and public buildings connected to the DH system; (d) electricity distribution network partial reconstruction; and (e) maintenance equipment, tools, and vehicles for the BEM district heating company. The project investments for Samarkand will include the following: (a) installation of two new gas-fired boilers with total capacity of 85 MW; (b) replacement of about 22.5 km (trench length) of DH network; (c) installation of 346 IHS to serve residential and public buildings connected to the DH system; (e) electricity distribution network partial reconstruction; and (d) maintenance equipment, tools, and vehicles for the DHC.

Component 2: Demand Side Investments. This Component would finance energy efficiency investments in buildings, i.e. renovation of the internal heat distribution pipelines and radiators within the buildings, installation of the apartment level heat meters and solar heating collectors, to reduce the need for heat and hot water services produced by gas run boilers. It would be co-financed by the government and the tenants of the residential multi-apartment buildings. The cost of the Component and specific co-financing and investment mechanisms would be determined during project preparation stage.

Component 3: Technical Assistance and Capacity Building. This component would finance capacity building for the participating district heating utilities and implementation support to the PCU, PIUs, and the participating utilities. The component would include (i) training and capacity building for the district heating utilities based on international best practices for energy efficiency improvements in district heating; (ii) implementation support consultancy to support the PCU and the utilities in the implementation and supervision of the project; (iii) social accountability measures through strengthening customer service departments within utility companies; (iv) social surveys of customer satisfaction after the project; (v) an annual financial audit of the project accounts; (vi) improvement of the institutional structure of the district heating system; (vii) public information campaign; and (vii) other consultancy services.

1.3. The scope of the project EA, its potential impacts and environmental category

Scope of the project EA. The main scope of the project Environmental Impact Assessment (EIA) and EMPs was to analyze the potential adverse environmental issues related to the proposed activities and to ensure that these aspects will be adequately addressed and mitigated during the project implementation in full compliance with WB requirements and National legislation. Along with the necessary mitigation measures it should also contain relevant monitoring and reporting activities as well as EMPs implementing arrangements.

Potential environmental impacts and project environmental category. Conducted EA concluded it will generate mostly positive socio-economic benefits due to the improvement of population hot water supply and heating services along with improved environmental conditions on the involved cities. Replacement and modernization of old inefficient boilers or installation of new ones will significantly reduce the level of pollutants emissions which will have significant effects on the health of population. At the same time, it might also generate a series of adverse impacts: noise; air pollution; impact on water quality and resources; impact on water by the construction run-offs; disturbance of traffic during construction and rehabilitation works; construction dust; and workers' safety, etc. However, these impacts will be temporary and site specific and could be easily mitigated through implementing adequate avoidance and/or mitigation measures. It was also concluded no impacts are expected on sensitive or protected areas. Furthermore, no any physical cultural resources will be involved/or impacted. Taking into consideration the character of potential impacts the project

was assigned as Category B for which it is necessary to conduct an EIA and prepare, for each of the included in the project city, a separate Environmental Management Plan (EMP).

The structure of the EA report. The EA report contains along with the WB safeguards policies applied to the current project and description of the policies, legal, and administrative framework regarding environmental management and the centralized heating sector in place in Uzbekistan as well as five site specific EMPs for participating cities (Andijan, Bukhara, Chirchik, Samarkand and Sergili district of Tashkent city). The EMPs contains: (a) the baseline analysis; (b) potential environmental impacts; (c) project alternatives; (d) necessary activities targeted at mitigating adverse environmental and social impacts; (c) monitoring plan for EMPs implementation. The last part of the EA report includes EMPs implementing arrangements as well as a short analysis of District Heating Companies' EA capacity and needed training in this regard.

2. ENVIRONMENTAL POLICY AND ENVIRONMENTAL ASSESSMENT REGULATORY CONTEXT

2.1. National environmental legislation and environmental assessment procedures

2.1.1 National Environmental Policies. The main priority for the Republic of Uzbekistan during the on-going economic reforms is to ensure reliable social guarantees and measures for social security and environmental protection[1]. Nature protection policy and the implementing measures in the areas of rational use of the natural resources and environment protection are based on the following main principles: (a) Integration of economic and ecological policy aimed at conservation and restoration of the environment as the essential condition for improvement of the living standards of the population; (b) Transition from protection of individual natural elements to the general and integrated protection of ecosystems; (c) Responsibility of all members of society for environment protection and conservation of biodiversity.

2.1.2 Environmental Legislation. Since independence Uzbekistan has approved more than 100 laws, revisions of old legislation designed to address environmental problems and manage environmental resources. Relevant environmental laws and regulations in the framework of the present Project include:

"On Environmental Protection" (1992), establishing a legal, economic and organizational framework for environment protection, ensuring sustainable development and defining principles including State Ecological Expertise (SEE);
"On Water and Water Use" (1993), ensuring rational water use, protection of water resources, prevention and mitigation of negative impacts and compliance with national legislation;
"On Land Code" (1998) provides basic norms and rules for land use and stipulates the land rights;
"On the Concept of National Security" (1997), a principle framework for achieving national ecological security, etc.;
"On the Protection and Use of Flora (plants)" (1997) regulates relations in the field of protection and use of flora (plants) growing in natural conditions, as well as wild plants kept under crop conditions for their reproduction and genetic conservation;
"On Ecological Expertise" (2001) provides for mandatory expert assessment of impacts on the environment and human health, as well as a legal basis for conducting expert assessments;
"On Ecological control" (2013) regulates relations in the field of environmental control. The main objectives of environmental control are prevention, detection and suppression of violations of environmental regulations; monitoring of environmental situations that may lead to environmental pollution, unsustainable use of natural resources, endangering the life and health of citizens.

Many important aspects of national environmental regulatory framework are provided by Decrees of the Cabinet of Ministers, such as:

"On regulation of ecologically dangerous product and waste shipments to and from the territory of the Republic of Uzbekistan" (No 151, 19.04.2001);
"On approval of the Regulation of the State Environmental Expertise" (No 491, 31.12.2001);

[1]Karimov Islam. 1999. "Uzbekistan: Towards 21-st Century", Report on the 14-th Session of Parliament (Oliy Majlis).

"On approval of the Provision for procedures for the cadastral division of territory of the RUz and formation of cadastral numbers for land plots, buildings and structures" (No 492, 31.12.2001);
"On approval of Provision on the State Environment Monitoring" (No 49, 3.04.2002);
"On rendering status of the specially protected natural territories of the republican importance to the fresh water aquifer formation zones" (No 302, 26.08.2002);
"On improvement of the Hydro-Meteorological Service" (No 183, 14.04.2004);
"On approval of the Program of the state environmental monitoring in the Republic of Uzbekistan for 2011-2015" (No 292, 31.10.2011);
"On the Action Program for the Protection of Environment in the Republic of Uzbekistan for 2013-2017" (No 142, 27.05.2013);

Nature Protection Normative Documents. Relevant nature protection normative documents issued by government include:

"Procedure for elaboration and execution of draft standards on maximum permissible emission of contaminants discharged to water bodies including drainage water" (RD 118.0027719.5-91);
"Procedure for granting permission for special water use" (RD 118.0027714.6-92);
"Instruction for determining of damage caused to the national economy by underground water contamination" (RD 118.0027714.47-95);
"Temporary recommendation on control of underground water protection of the Republic of Uzbekistan". State Nature Committee and *Uzbekgidrogeologiya* of the Republic of Uzbekistan, Tashkent, 1991;

International Cooperation and Global and Regional Agreements: In the context of the global environment, the Republic of Uzbekistan is a Party to three Rio Conventions: the Convention on Climate Change, Convention on Biological Diversity, and Convention to Combat Desertification, together with a number of other international Conventions, Protocols, Agreements, and Memoranda of Understanding in the areas of environmental conservation and sustainable development. Other global agreements to which Uzbekistan is party include:

- Convention on Prohibition of Military or Any Aggressive Destructive Actions to the Environment (26.05.1993);
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (22.12.1995);
- Convention on Protection of the World Cultural and Natural Heritage (22.12.1995);
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (01.07.1997);
- Bonn Convention on Conservation of Migrating Species of Wild Animals (01.05.1998);
- Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat (30.08.2001).

2.1.3 Technical district heating norms. The existing norms and design instructions for the heating sector in the country originate in the Soviet period and are based mainly on Group Heating Systems. In this context, the relevant documents used by designers are NCM G.04.07-2006 "Thermal Networks" (Uzbek construction norm based on the Russian identical norm adopted by Uzbekistan and a number of other CIS states) and the Manual for Design of Heating Substations (Moscow, Stroyizdat, 1983). Many requirements are unified for

substations of all sizes and types - from large GHSs to IHSs, from substations using high-pressure steam to lower temperature hot water DH. Designing IHSs in accordance with the above makes the substations more expensive than similar IHSs designed according to western practice. This is related to the use of a larger number of elements, in particular - shutoff valves between pieces of equipment (pumps, heat exchangers, etc.), and some redundancy measures.

2.1.4 EA rules and procedures. State Environmental Expertise (SEE), i.e. preparation of or the review and approval (or rejection) of developments on environmental grounds, is regulated Law on Ecological Expertise (2000) andby Decree of the Cabinet of Ministers No 491.31.12.2001: "*On approval of the Regulation of the State Environmental Expertise"*.

According to the article 3 of the abovementioned law Ecological expertise is carried out in order to determine:

- compliance of projected economic and other activities with environmental requirements in the stages preceding decision making on its implementation;
- level of ecological danger planned or carried out business and other activities, which may have or had a negative impact on the condition of the environment and public health;
- adequacy and reasonableness of the measures provided for the protection of the environment and rational use of natural resources.

The main responsible organization for state environmental review is the Main Directorate for State Ecological Expertise (*Glavgosecoexpertiza*) of Goskompriroda. The Regulation stipulates 4 categories for development:

Category I –Corresponds to World Bank category A;
Category II –Corresponds to World Bank category B;
Category III –Corresponds to World Bank category Bor C;
Category IV - Corresponds to World Bank category C.

According to the paragraph 11 of the Regulation, evaluation stages of the environmental impact should include the following basic issues (depending on the type and nature of work):

a) Draft statement on environmental impacts (DSEI):

- environmental conditions prior to the implementation of the planned activities, population of the territory, land development, analysis of the environment's features;
- situational plan showing existing recreational areas, settlements, irrigation, reclamation facilities, farmland, power lines, transport communications, water, gas pipelines and other information about the area;
- envisaged major and minor objects, used technique, technology, natural resources, materials, raw materials, fuel, analysis of their impacts on the environment, environmental hazards of their products;
- expected emissions, discharges, wastes, their negative impact on the environment and ways of neutralization;
- warehousing, storage and disposal of wastes;
- analysis of the alternatives of the proposed or existing activity and technological solutions from the perspective of environmental protection, taking into account the achievements of science, technology and best practices;

- organizational, technical, technological solutions and activities, excluding the negative environmental impacts and mitigating the impact of the expertising object on the environment;
- analysis of emergency situations (with an estimate of probability and scenario of the prevention of their negative impacts);
- forecast environmental changes and environmental impacts as a result of the implementation of the expertising object;

b) Statement on environmental impact (SEI):

- assessment of environmental problems of the chosen site on the results of engineering-geological invesigations, modeling and other necessary researches;
- environmental analysis of technology applied to the issues identified on the site;
- the results of the public hearings (if necessary);
- reasoned investigations of the nature-conservative measures to prevent the negative consequences of the expertising object;

c) Statement on Environmental Consequences (SEC):

- correction of the design decisions and other taken measures on the consideration of the DSEI by the bodies of Goskompriroda, as well as on the proposals made at the public hearings;
- environmental regulations governing the activities of the expertising object;
- requirements for the organization of work and the implementation of measures for environmental guiding of the operation of the object;
- main conclusions about the possibility of business activities.

2.1.5. State Organizations Responsible for Environmental Assessment and Management. The State Committee for Nature Protection (*Goskompriroda*)[2] is the primary environmental regulatory agency. It reports directly to the *Oliy Majlis* (Parliament), and is responsible, at central, oblast and raion levels, for coordinating the environmental and natural resources actions of other national government bodies. The mandate of *Goskompriroda* is based on the Regulation *"On the State Environmental Committee of the Republic of Uzbekistan"* as approved by Parliament on 26 April 1996.

Goskompriroda is responsible for environmental and natural systems protection. It oversees the national system of protected areas, can initiate liability/damage actions, and administers an Environmental Fund which receives pollution fees and penalties and supports pollution mitigation measures. There are also several scientific institutes attached to the *Goskompriroda* which conduct analysis on environmental and natural resources problems and measures to address these in support of *Goskompriroda*'s work.

Goskompriroda also issues permits for pollution discharge emissions and may prohibit projects and construction works that do not comply with (international) legislation. Fees are collected at the regional level for the use of resources, for licences to discharge polluting material, and for waste disposal.

The structure of *Goskompriroda* takes the form of a central body in Tashkent, with regional (oblast) and local (raion) branches and agencies for scientific and technical support. Regional

[2] In English translations also called 'State Committee for Nature Conservation', 'State Committee for Natural Resources', 'Committee of Nature Control', etc.

level organisations have the same structure as those at national level. Different departments take responsibility for environmental standards, environmental law, international relations, environmental funding, economics, publicity, and governmental ecological review.

2.1.6. Public Involvement. The Sub-borrower is also responsible for conducting at least one public consultation(s) for category I and II. These responsibilities include: (a) public notification, (b) conducting the consultation and (c) recording the significant findings, conclusions, recommendations and next steps. The purpose of public consultation(s) is (are) to solicit views of groups or individuals who may be affected by the Sub-project regarding their environmental concerns. Affected groups or people should identify the environmental issues they believe to be significant. *Any significant issues, established during the public consultation, should be incorporated into the EMP.* Public disclosure provides affected groups or individuals the opportunity to examine the draft EMP document before it is finalized so that they can review and provide comments on the mitigating measures agreed upon and the responsibilities for implementing them. Since Uzbek and World Bank consultation and disclosure requirements may differ somewhat, World Bank requirements presented below are the primary ones and have to be followed.

2.2. The World Bank Safeguards Policy and Environmental Assessment Requirements

2.2.1 Overview. The Bank undertakes environmental screening of each proposed project for which it will provide funding in order to determine the appropriate extent and type of environmental assessments (EA). The Bank classifies a proposed project into one of four categories, depending on the type, location, sensitivity and scale of the project and the nature and magnitude of its potential environmental impacts. The four EA Categories are A, B, C, and FI. Category FI is applied to all proposed projects that involve investment of Bank funds through a participating financial intermediary (PFI) to be used for sub-projects of which the environmental impacts cannot be determined during appraisal of the World Bank project.

2.2.2. World Bank's Safeguard Policies and their relevance to project. There are key 10 Environmental and Social World Bank Safeguard Policies which are intended to ensure that potentially adverse environmental and social consequences of projects financed by Bank are identified, minimized and mitigated. World Bank Safeguard Policies have a three-part format: Operational Policies (OP) - statement of policy objectives and operational principles including the roles and obligations of the Borrower and the Bank, Bank Procedures (BP) - mandatory procedures to be followed by the Borrower and the Bank, and Good Practice (GP) - non-mandatory advisory material. World Bank's Safeguard Policies and their relevance to sub-projects to be funded under the Competiveness Enhancement Project's New Credit Line Component are indicated in the *Table 1* below.

Table 1. World Bank's Safeguard Policies and their relevance to sub-project

Safeguard Policies	*Relevance*
Environmental Assessment (OP/BP 4.01) This Policy aims to ensure that projects proposed for Bank financing are environmentally and socially sound and sustainable; to inform decision makers of the nature of environmental and social risks; To increase transparency and participation of stakeholders in the decision-making process	This OP is triggered as district heating rehabilitation and installation of new equipment and technologies might generate some environmental impacts such as: dust, noise, soil removal and destruction, occupational hazards, traffic disruption, construction wastes, etc. To address these issues the borrower conducted EIA and prepared for each participating city an Environmental Management Plan (EMP), which

	is based on WB and national EA rules and procedures. The EMPs have been disclosed and publicly consulted in the involved cities with participation of all key stakeholders and local population. The EMPs will be used for project implementation.
Natural Habitats (OP/BP 4.04) This Policy aims to safeguard natural habitats and their biodiversity; avoid significant conversion or degradation of critical natural habitats, and to ensure sustainability of services and products which natural habitats provide to human society	As the project will be implemented within city boundaries, there are no natural habitats in its vicinity and thus this OP is not triggered.
Forestry (OP/BP 4.36) This Policy is to ensure that forests are managed in a sustainable manner; significant areas of forest are not encroached upon; the rights of communities to use their traditional forest areas in a sustainable manner are not compromised	This OP is not triggered as the project will be implemented within the city boundaries and there are no forest areas in its vicinity.
Pest Management (OP 4.09). This policy is to ensure pest management activities follow an Integrated Pest Management (IPM) approach, to minimize environmental and health hazards due to pesticide use, and to contribute to developing national capacity to implement IPM, and to regulate and monitor the distribution and use of pesticides	N/A
Physical Cultural Resources (OP/BP 4.11) This policy is to ensure that: Physical Cultural Resources (PCR) are identified and protected in World Bank financed projects; national laws governing the protection of physical cultural property are complied with; PCR includes archaeological and historical sites, historic urban areas, sacred sites, graveyards, burial sites, unique natural values; implemented as an element of the Environmental Assessment	This OP is also not triggered as during the EA was confirmed no any buildings which are specified in the list of national Physical Cultural resources will be included in the project and/or will be impacted by the project activities.
Indigenous Peoples (OP/BP 4.10) IP – distinct, vulnerable, social and cultural group attached to geographically distinct habitats or historical territories, with separate culture than the project area, and usually different language. The Policy aims to foster full respect for human rights, economies, and cultures of IP, and to avoid adverse effects on IP during the project development.	N/A
Involuntary Resettlement (OP/BP 4.12) This policy aims to minimize displacement; treat resettlement as a development program; provide affected people with opportunities for participation; assist displaced persons in their efforts to improve their incomes and standards of living, or at least to restore them; assist displaced people regardless of legality of tenure; pay compensation for affected assets at replacement cost; the OP Annexes include descriptions of Resettlement Plans and Resettlement Policy Frameworks	As the project will support installation of new local and mini (container) boilerhouses in participating cities, it might generate some resettlement impacts and thus this OP is triggered. To address these impacts the borrower designed a Resettlement Management Framework which will be applied in all participating cities.
Safety of Dams (OP/BP 4.37) This Policy is to ensure due consideration is given to the safety of dams in projects involving construction of new dams, or that may be affected by the safety or performance of an existing dam or dams under construction; important considerations are dam height & reservoir capacity	N/A
Projects on International Waterways (OP/BP7.50) The Policy aims to ensure that projects will neither affect	N/A

the efficient utilization and protection of international waterways, nor adversely affect relations between the Bank and its Borrowers and between riparian states	
Disputed Areas (OP/BP 7.60) The Bank may support a project in a disputed area if governments concerned agree that, pending the settlement of the dispute, the project proposed for one country should go forward without prejudice to the claims of the other country	N/A
Disclosure Policy (BP 17.50) supports decision making by the borrower and Bank by allowing the public access to information on environmental and social aspects of projects and has specific requirements for disclosure	Yes. (the EMF will be disclosed and consulted in the country before appraisal and will be also disclosed in the WB Infoshop)

2.2.3. World Bank Screening Categories and Environmental Assessment Procedures. Environmental Screening is a Mandatory Procedure for the Environmental Assessment 4.01 OP/BP. The Bank undertakes environmental screening of each proposed project for which it will provide funding in order to determine the appropriate extent and type of the Environmental Assessment to be conducted. The Bank classifies a proposed project into one of four categories, depending on the type, location, sensitivity and scale of the project and the nature and magnitude of its potential environmental impacts[3]. These four Categories are A, B, C, and FI.

Category A projects are likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may be sensitive, irreversible, and diverse, with attributes such direct pollutant discharges large enough to cause degradation of air, water, or soil; large-scale physical disturbances of the site and/or surroundings; extraction, consumption, or conversion of substantial amounts of forest and other natural resources; measurable modifications of hydrological cycles; hazardous materials in more than incidental quantities; and involuntary displacement of people and other significant social disturbances. The impacts are likely to be comprehensive, broad, sector-wide, or precedent-setting. Impacts generally result from a major component of the project and affect the area as a whole or an entire sector. They may affect an area broader than the sites or facilities subject to physical works. The EA for a Category A project examines the project's potential negative and positive environmental impacts, compares them with those of feasible alternatives (including the "without project" scenario), and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance. For a Category A project, the borrower is responsible for preparing a report, normally a full Environmental Impact Assessment (or a suitably comprehensive regional or sectoral EA).

Category B projects has potential adverse environmental impacts on human populations or environmentally important areas - including wetlands, forests, grasslands, and other natural habitats - which are less adverse than those of Category A projects. These impacts are site-specific; few if any of them are irreversible; and in most cases mitigation measures can be designed more readily than for Category A projects. The scope of EA for a Category B project may vary from project to project, but it is narrower than that of Category A assessment. Like Category A, a Category B environmental assessment examines the project's potential negative and positive environmental impacts and recommends any measures needed

[3] See: Environmental Assessment Update Sourcebook, Environmental Department April 1993. The World Bank

to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance.

Category C. An EIA or environmental analysis is normally not required for Category C projects because the project is unlikely to have adverse impacts; normally, they have negligible or minimal direct disturbances on the physical setting. Professional judgment finds the project to have negligible, insignificant, or minimal environmental impacts. Beyond screening, no further EA action is required.

Category FI. A Category FI project involves investment of Bank funds through a financial intermediary, in subprojects that may result in adverse environmental impacts.

The Bank reviews the findings and recommendations of the EA to determine whether they provide an adequate basis for processing the project for Bank financing. When the borrower has completed or partially completed EA work prior to the Bank's involvement in a project, the Bank reviews the EA to ensure its consistency with this policy. The Bank may, if appropriate, require additional EA work, including public consultation and disclosure.

Screening criteria. The selection of the category should be based on professional judgment and information available at the time of project identification. If the project is modified or new information becomes available, Bank EA policy permits to reclassify a project. For example, a Category B project might become Category A if new information reveals that it may have diverse and significant environmental impacts when they were originally thought to be limited to one aspect of the environment. Conversely, a Category A project might be reclassified as B if a component with significant impacts is dropped or altered. The option to reclassify projects relieves some of the pressure to make the initial decision the correct and final one.

Projects in Category B often differ from A projects of the same type only in scale. In fact, large irrigation and drainage projects are usually Category A, however, small-scale projects of the same type may fall into Category B, the same relates to aquaculture projects and many others. Projects entailing rehabilitation, maintenance or upgrading rather than new construction will usually be in Category B. A project with any of these characteristics may have impacts, but they are less likely to be “significant”. However, each case must be judged on its own merits. Many rehabilitation, maintenance and upgrading projects as well as privatization projects may require attention to existing environmental problems at the site rather than potential new impacts. Therefore, an environmental audit may be more useful than an impact assessment in fulfilling the EA needs for such projects.

The selection of a screening category often depends also substantially on the project setting, while the “significance” of potential impacts is partly a function of the natural and socio-cultural surroundings. There are a number of locations which should cause to consider an “A” classification:

- in or near sensitive and valuable ecosystems - wetlands, natural areas, habitat of endangered species;
- in or near areas with archaeological and/or historical sites or existing cultural and social institutions;
- in densely populated areas, where resettlement may be required or potential pollution impacts and other disturbances may significantly affect communities;

- in regions subject to heavy development activities or where there are conflicts in natural resource allocation;
- along watercourses, in aquifer recharge areas or in reservoir catchments used for potable water supply; and
- on lands and in waters containing valuable natural resources (such as fish, minerals, medicinal plants; agricultural soils).

The World Bank's experience has shown that precise identification of the project's geographical setting at the screening stage greatly enhances the quality of the screening decision and helps focus the EA on the important environmental issues.

***2.2.4. World Bank Public Consultation and Disclosure requirements*.** For all Category A and B projects proposed for WB financing, during the EA process, the borrower consults all involved parties, including project-affected groups and local nongovernmental organizations (NGOs) about the project's environmental aspects and takes their views into account. The borrower initiates such consultations as early as possible. For Category A projects, the borrower consults these groups at least twice: (a) shortly after environmental screening and before the terms of reference for the EA are finalized; and (b) once a draft EA report is prepared. In addition, the borrower consults with such groups throughout project implementation as necessary to address EA-related issues that affect them. For meaningful consultations between the borrower and project-affected groups and local NGOs, the borrower provides relevant material in a timely manner prior to consultation and in a form and language that are understandable and accessible to the groups being consulted. For a Category A project, the borrower provides for the initial consultation a summary of the proposed project's objectives, description, and potential impacts; for consultation after the draft EA report is prepared, the borrower provides a summary of the EA's conclusions. In addition, for a Category A project, the borrower makes the draft EA report available at a public place accessible to project-affected groups and local NGOs. Any Category B EIA report for a project proposed for WB financing is made available to project-affected groups and local NGOs. Public availability in the borrowing country and official receipt by the Bank of Category A reports for projects proposed for WB financing, and of any Category B EA report for projects proposed for WB funding, are prerequisites to Bank appraisal of these projects.

Figure 1 presents the different steps in the project cycle and shows how the various EA phases fit in the project preparation process. The main EA phases concern screening, scoping, EA, and environmental management plan during and after implementation of the project - covering mitigation, monitoring and evaluation.

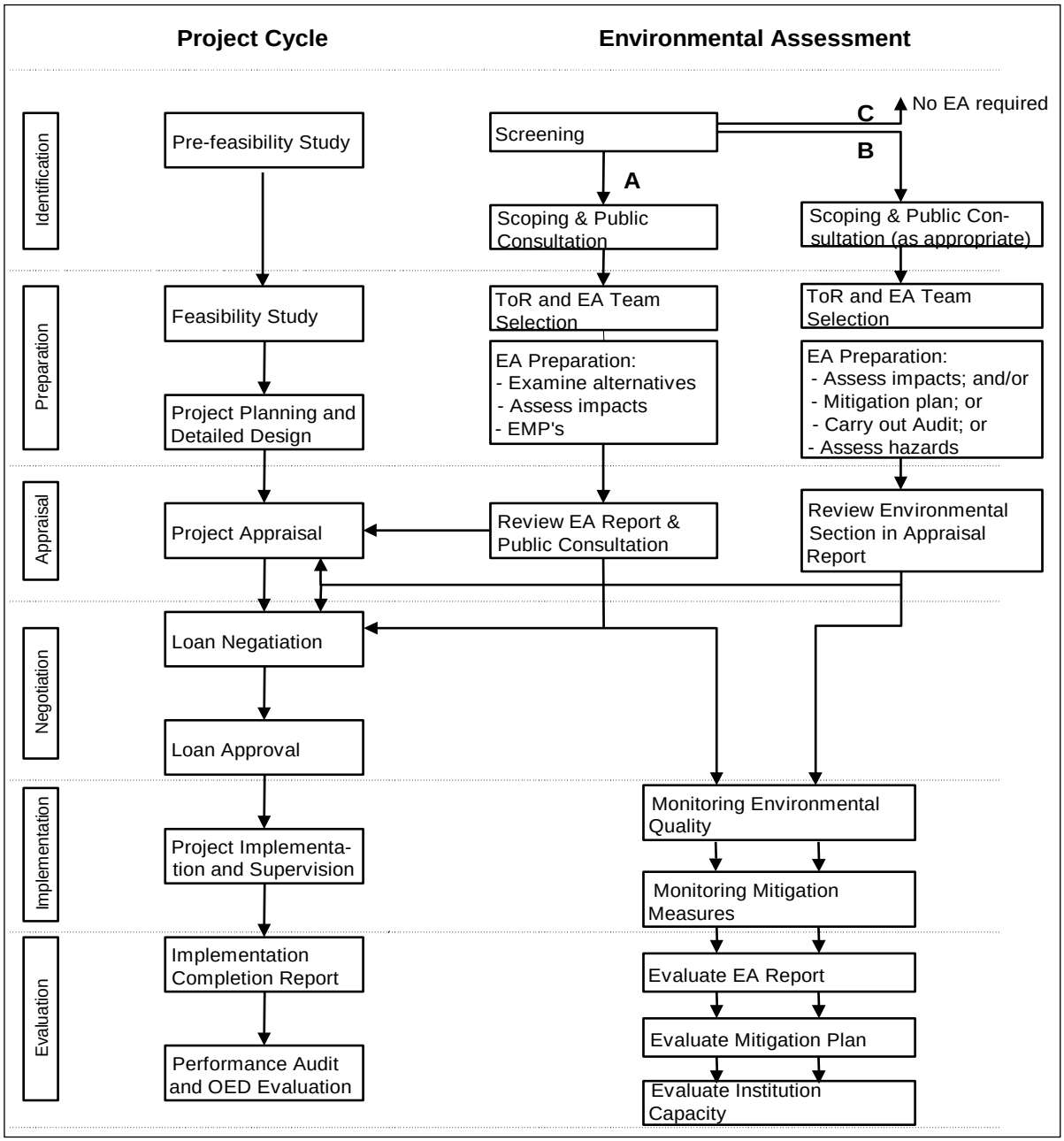

Figure 1. Environmental Assessment and the World Bank project cycle

2.3. The comparison of national and World Bank EA requirements

2.3.1. Overview. While the basic provisions of the National EA rules and procedures are to some extent similar to the WB requirements, there are several important differences. These differences are related primarily to the following: (a) requirements to have an Environmental Management Plan; and (b) requirements concerning EA disclosure and public consultation.

2.3.2. Differences concerning EMP. While the national legislation requires for all projects with potential environmental impacts relevant mitigation measures, it doesn't require a special EMP which should specify, along with the proposed mitigation activities a monitoring plan and reporting requirements, institutional arrangements for EMPs implementation as well as doesn't require needed capacity building activities and necessary expenses in this regard. To

comply with World Bank requirements in this regard the client agreed to prepare for all participating cities special EMPs.

2.3.3. Differences with regard to disclosure and public consultation. Conducted analysis shows there is no harmonization between World Bank and national requirements in this regard. According to national legislation, the EA disclosure and public consultation is mandatory only for category I and II. At the same time, the of EA review in the country shows this requyirement is not always followed in practice. In the case of World Bank EA policy, the Sub-borrower is responsible for conducting at least one public consultation for all Category B projects to discuss the issues to be addressed in the EMP or to discuss the draft EMP itself. Therefore, to comply with this requirement, the client will ensure all EMPs (once their full drafts will be ready) will be disclosed and consulted in participating cities. Uzbek language and/or local language version of the EMPs and the record of the public consultation should be placed on the Sub-borrower website and submitted to the cities' councils. The EA documents should be made available to all roject-affected groups of population and local NGOs in an easily accessible on the client website.

3. ENVIRONMENTAL IMPACT ASSESSMENT & ENVIRONMENTAL MANAGEMENT PLAN FOR PARTICIPATING CITIES

3.1. EIA& EMP for Andijan city

3.1.1. Current status of city's district heating system and proposed investments.

Andijan is a large regional, industrial, and cultural center located in the south-east of Fergana Valley. It is the only regional center in Uzbekistan where currently there is no heat and hot water supply in multistory residential buildings. In the city there are various types of houses in the city with the great majority of one-story buildings. The total number of multi-apartment buildings is 701 of which with independent in-house gas heating – 85 and connected to district heating – 616. Of last buildings 548 are connected to Issiklikmanbai boiler-houses and 68 connected to industrial boiler-houses. However, there was no district heating in residential buildings in the last years due to the poor state of heating sources and networks.

The majority of multi-story residential buildings are located in Kusharik, Shimoliy, Buston, Dukchi and Eshon residential areas and micro-districts 1, 2, 3, 4, 5. Public education, health, preschool facilities and other public buildings far from district heating sources and not connected to district heating mains often have individual heating stations – obsolete and exhausted low efficient "Universal" and type STVK boilers. The city's 3 higher educational institutions, 50 secondary schools, 28 lyceums and occupational colleges, 554 preschool facilities, 25 healthcare institutions, and 4 sports schools have their own individual heating systems with obsolete, exhausted and low efficient water heating boilers.

The curent heat supply system in Andijan is open meaning that hot water from DH network is directly used for heating and providing hot water. In the closed system all buildings shall be equipped with two heat exchangers; one for heating and one for hot water. The hot water water circulating in the hot domestic water pipes is not district heating water but comes from the water utility and is heated in the heat exchangers. Heating networks are double-piped and constructed mostly under the ground in reinforced concrete ducts, in the areas of high groundwater level. Similarly, to the BH main equipment, service life of heating networks is 25 years which is above the norm. Normative standard for pipeline operation is about 20-25 years. Too long operation of heating networks resulted in damaged heating insulation of pipes in many sections, corrosion of shut-off valves and steel pipelines. Exhausted heating networks are the cause for lower water temperature in the network, unstable heat supplying to consumers, and regular accidents with heat outages for multistory residential buildings. At present, heat losses in heating networks are twice as high as normative standards (5%). Actual water temperature in supplying network does not exceed 65°C and return water temperature is 45°C against the normative standards of 150°C and 70°C, respectively. Recovery of heat losses results in excessive consumption of fuel, water refilling due to its leaks from corroded pipeline sections results in extra consumption of water. Residents of micro-districts (3, 4, 5 and Kusharik) located far from district heating and hot water supply sources suffer from low heating more than the others.

Up to date, Andijan consumers have been receiving heating from large and small-size boiler-houses (BH) operated by Andijan regional "Issiklikmanbai" heating company and from governmental and industrial BHs that supply enterprises and adjacent residential buildings with heat. As of January 1, 2013, there were 26 "Issiklikmanbai" company boiler-houses with total capacity of 347 Gcal/hr, of which only 10 boiler-houses with capacity of 41.9 Gcal/hr

operated during the 2011-2012 heating season. They supplied heat to healthcare, social and cultural facilities.

District boiler houses – BH-1 and BH-2 – were the largest heating sources for residential and public buildings in Andijan. The district BH-1 ("Sever") with the initial capacity of 94.9 Gcal/hr was built in 1978 and developed in 1999. The boiler-house is equipped with 3 water heating boilers (PTVM-30) to generate heat for heating and hot water supply and 3 steam boilers (E-1/9) for fuel heating up (mazut). This BH heating system is open. Natural gas is used as primary fuel, mazut – as reserve fuel. BH-1 was supposed to supply heat to 144 multi-apartment buildings in Shimoliy, Kusharik, and Medgorodok microdistricts, social, cultural and utility service buildings in remote microdistricts, 2 schools, 8 preschool facilities and some other buildings. *The boiler-house has not been working since 2006*.

The district BH-2 with the initial capacity of 179.4 Gcal/hr was built in 1976 and developed in 1989. It is equipped with 3 water heating boilers (1 PTVM-50 and 2 KVGM-50 – gas-mazut (heavy oil) heating boilers) and 3 steam boilers (1 DKVR 10/13 and 2 DE 16/14). Water heating boilers PTVM-50 and 2 KVGM-50 are intended to generate heat for heating and hot water supply, steam boilers DKVR 10/13 and 2 DE 16/14 for heating-up of mazut. Natural gas is used as primary fuel, mazut – as reserve fuel. BH-2 was expected to supply heat to 242 multi-apartment buildings in micro-districts 1, 2, 3, 4 and 5, as well as 5 secondary schools, 15 preschools, a children's sports school, schools of boxing and athletics and other social, cultural, and utility facilities located in remote micro-districts. The majority of boiling equipment has been operated for more than 30 years with low efficiency factor; 60~85% of them are exhausted and their further operation does not seem reasonable. *This boiler-house has not been working since 2010.*

Analysis of the current heat and hot water supply system in Andijan shows poor condition of main and sub-main heating networks and in-house heat and hot water supply systems. Heat supplies are insufficient to meet needs in heat and ensure comfort conditions for consumers. Large district BH-1 and BH-2 have been operated for more than 30 years. Their equipment is exhausted, and current maximum load is only 20% of the initial capacity. Due to exhausted heating networks, heat losses are much higher than normative standards, and there is no hot water in residential buildings.

Overall performance of heat sources, main and distribution heating networks and in-house heating and hot water systems is assessed as poor. Supplied heating energy is inadequate to ensure heat and comfort for consumers, and residential buildings do not have heating at all. As a result, residents use gas and electrical devices for heating and hot water. In most cases, heating devices are defective and do not meet fire safety requirements. It results in excessive use of natural gas and electricity and affects fire safety of buildings.

Modernization and rehabilitation of the heating system in Andijan aim to: (a) ensure adequate supply of consumers with heating; and (b) improve cost effectiveness of the enterprise by decreasing costs of energy resources per unit of energy generation, generate more heat and improve its quality, introduce new energy efficient technologies and equipment. Main objectives to be achieved through reconstruction include the following: (a) create a modern scheme of high-quality uninterrupted and resource efficient heating and select the most appropriate heating options to meet the needs of population, social institutions and other economic entities in heat to ensure comfort temperatures in residential and public buildings; (b) develop technical solutions for improving technical qualities of existing facilities,

buildings, apartments and residential houses, improve social protection of citizens due to guaranteed heating and lower costs for heating consumers; (c) improve cost effectiveness of production and quality of services with the introduction of quality standards at heating facilities, introduction of a modern centralized system to control heating generation and consumption; (d) configure local heating equipment so as to technically arrange regulation of temperature in premises and to ensure metering of heat and hot water in each apartment by electronic devices with further transfer of information to the heating consumption control and metering system of a heating enterprise; (e) use efficient construction materials to insulate heating networks that would reduce heat losses in soil or ambient air; (g) optimize a heating technological scheme and select appropriate equipment; (h) automate production and develop technical facilities and instrumentation for automated data management system; and (j) develop optimal solutions for selecting a heating supply scheme. Introduction of new technologies will save natural gas, enable to more efficiently use fuel and significantly reduce air pollutant emissions.

The heating system will be transformed into a closed system with installation of individual heating substations in each building and introduction of horizontal distribution piping which allows mettering of heat consumption in each appartment and will cover 701 multistory residential buildings and 65 public buildings. 481 multistory residential buildings and 65 public buildings will be supplied with heat from rehabilitated BH-1 and BH-2 and 7 new local BHs. 220 multistory residential buildings far from heating zones will be supplied with heat from 59 new mini boiler-houses (see *table 2*).

Table 2. Construction works projected in 2015–2017

Works	Measurement unit	Quantity	Breakdown by years		
			2015	2016	2017
BH-1 and BH-2 rehabilitation	Boiler-house	2	2		
Reconstruction of in-house heating systems	Residential building	481	140	160	181
Construction of individual heating substations in residential buildings	IHS	481	140	160	181
Construction of individual heating substations in public buildings	IHS	65	16	22	27
Construction of local BHs	Boiler-house	7	2	2	3
Installation of mini BHs	Boiler-house	59	13	18	28
Reconstruction of main and distribution heating networks	km	40	12	12	26
Construction of high and medium pressure gas pipelines and medium pressure local pipes to the projected BHs in “Kusharik” and “Sever” microdistricts (with a diameter of 219-426 mm)	km	10.87	10.87		
Heat generation	×10³ Gcal	612.044	203.81	407.92	612.044
Heat distribution	×10³ Gcal	582.899	194.10	388.21	582.899

A closed heating system with the use of individual heat substations will have some advantages against the existing heat supply system:

- Energy consumption for water pumping is reduced by 20~40%;
- Because of automated regulation of heat supply to a consumer (building), up to 15% of

heat will be saved;
- Heat losses due to hot water transportation will be halved;
- Number of heat network accidents will be significantly reduced if hot water supply pipelines are excluded from the networks;
- Heat comfort in buildings is maintained automatically through controlling of the following parameters: temperature and pressure of heating and running water; indoor air temperature (in monitored locations) and outdoor temperature;
- Payment for heat consumption by each building is based on actually measured consumption due to the use of metering devices;
- Significant cost reduction for in-house heating systems due to the use of pipes with a smaller diameter and non-metal materials;
- Heat will be saved and cost of installation works will be reduced as equipment will be fully assembled by manufacturers. Heat saving will be around 20~30%;
- Feed water costs will be reduced and consequently water treatment costs will be reduced as well.

3.1.2. Baseline analysis

Climatic Conditions. Climate of the area is distinctly continental. Winters are relatively mild, monthly average temperature varies from –4 to + 6^{o}C. January and February are the coldest winter months. Absolute minimum of winter temperature is –29^{o}C.

Precipitation falls in the form of rain and snow. From April to August heavy rains are possible, in summer there are exceptionally thunderstorms related to highly developed convention during heavy air intrusions. Of all types of precipitation, rainfalls prevail (65%) followed by solid (16%) and mixed precipitation (19%). Solid precipitation is most common in January and February. Precipitation in cold seasons is 1.5-times higher than in warm seasons. Annual average precipitation varies from 240 to 260 mm. Duration of seasonal snow coverage does not exceed 30 days.

Summers are dry and hot. Monthly average temperature is +25-36^{o}C, absolute summer maximum is +41^{o}C. Variable winds are mostly west and south-west and sometimes east. Average wind velocity is 1-2.5 m/sec, some gusts are as fast as 15-20 m/sec. Number of days with heavy wind gusts does not exceed 4-5 days a year.

Fergana Valley is locked (naturally protected) by massive mountain ranges that are 3-5 km higher than the valley is protected from external air flows. At the same time, this contributes to air natural and man-made pollution, higher frequency of air stagnation and inversion phenomena. It has been found that air purification and air pollutant outflow from the valley are possible only with massive air intrusions.

Fergana Valley is dominated by meteorological processes that have both positive and negative impact on air pollutant dispersion. The following are the determinants of area pollution: low eolation, air blanketing, medium frequency of temperature inversions (40%) and low precipitation depth. Temperature inversion in the lower troposphere is one of the most significant meteorological factors intensifying air pollution. Ground-level inversions depress turbulent dispersion and contribute to accumulation of hazardous substances, especially if the orifice is lower than the upper bound of inversion. The longer the inversion, the higher is the probability that the air will be heavily polluted. The longest inversion is reported in

December, inversion in January-April is shorter. It has been found that air pollution of the area is determined by air pollution of the entire Fergana Valley rather than by local emissions.

Air pollution level. Currently the following are the main sources of air pollution in the city: hydrolysis plant ("Uzhimprom"), "Electrodvigetel" plant (production of electrical equipment), "Andijangydromash" (Uzbek State Machine Building Enterprise), cotton refinery, fats and oils producer, dairy and cannery plants, machine building plant, meat factory, brick-making plant 13 (Uzbek construction materials). According to the RUz State Statistics Committee's data, emissions from these sources amounted to 9,545 tons of hazardous substances in 2013, of which 1,125 tons of solid substances, 759 tons of sulfur dioxide, 1,409 tons of carbon oxide, 312 tons of nitrogen oxide, 3,722 tons of hydrocarbons (without VOC), and 2,111 tons of volatile organic compounds.

Motor roads with the most intensive traffic and high levels of pollutants from petrol engines include Navoi Avenue, Chulpon, Babur, Ashurov, Musaev, Sajoat, Altinkulskaya, Budenniy, Atabekov, Gagarin, Khmelnitskiy, Kh. Zade, Oshskaya, and many other streets. The share of motor vehicles in total gross pollutant emissions is > 50%. Other sources of air pollution are motorcar exhaust gases, especially along the highways Andijan-Osh and Kharabek-Buston which contain over 200 toxic compounds dominated by nitrogen oxides, carbon oxide, and hydrocarbons. Thus, large industrial and energy enterprises and numerous motor vehicles are the main sources of air pollution. In "Bobur" and "Bakirov" shirkats, which land will be partially crossed by gas pipelines of new boiler-houses, environmental impact sources will include boiler-houses, construction enterprises, agricultural enterprises, and motorways. Emissions from these enterprises contain dust, nitrogen oxides, sulfur dioxide, hydrocarbons, soot, aldehydes, and benzapyrene.

To assess the current level of air pollution, project developers used the data of occasional expeditionary surveys of the Center of Baseline Air Pollution Monitoring under the RUz State Hydrometeorological Committee. The following data characterize air pollution in the area: (a) Pollution with dust - 0.6 MPL; (b) Sulfur dioxide - 0.02 MPL; (c) Nitrogen dioxide - 0.5 MPL; and (d) Carbon oxide - 0.4 MPL. Concentrations of all substances tend to reduce and stabilize.

Air pollution from heating sources. As described above, local boiler-houses in Andijan city are located mainly at schools and hospitals. They are typically equipped with the following boilers NR-17, NR-18, KV-0,3, KV-0,5, E-1-9GM, UN-5, UN-6, AN-3, ANKOM-2, DKVR-6,5/13, and fueled by gas in most cases. Besides, industrial boiler-houses are also heating sources typically equipped with DKVR, Universal-6, and other boilers. Most of them are fueled by gas, and there are a few boiler-houses fueled by mazut, diesel fuel, and coal. The rest of the city – mainly, private houses and two-story buildings – are heated by local boiler-houses or individually.

District BH (PTVM-30 at "Sever" DBH, PTVM-50 and KVGM-50 at DBH-2) are intended to supply heating and hot water to residential areas Sever and Kusharik ("Sever" DBH) and microdistricts 1-5 (DBH-2). These BHs use gas and mazut as fuel. Fuel consumption of "Sever" DBH is: 7,873 thousand m^3/year for natural gas, 5,432 tons/year for mazut; DBH-2 consumes natural gas (9,245 thousand m3/year) and mazut (8,312 tons/year).

In the process of fuel burning, chimneys (2 chimneys per each boiler-house) will emit nitrogen, sulfur, and carbon oxides, soot, vanadium pentoxide, and benzapyrene. Waste gases

are sucked by induced fans DN-21 GN. Parameters of emission sources at "Sever" DBH: height of a chimney connected to water heaters is 46 m, its diameter is 2.1 m, height of a chimney connected to steam boilers is 25 m, its diameter is 0.35 m; at DBH-2: height of the first chimney is 53 m, its diameter is 2.5 m, height of the second chimney is 90 m, its diameter is 2.5 m. Statistical data on air pollutant emissions of district boiler-houses in Andijan are presented in *Table 3.*

Table 3. Pollutant emissions of district boiler-houses (tons/year)

Boiler-house	NO_2	SO_2	CO	Soot	V_2O_5	Total*
"Sever" DBH	41.1	266.53	144.64	4.34	1.07	458.854
DBH-2	54.69	407.653	195.82	6.65	1.634	668.161

*Including hydrocarbons from mazut storage containers

For mazut storage, each site of the district boiler-houses is provided with: two above-ground metal containers with a volume of 425 m^3 at "Sever" DBH, and two underground concrete containers with a volume of 2000 m^3 at DBH-2. In addition, DBH-2 has two concrete containers (1000 m^3) for light liquid fuel storage. In cases of mazut and light liquid fuel storage, hydrocarbons enter the air through container's vent valves. According to statistical data, annual hydrocarbon emissions from liquid fuel storage containers at "Sever" DBH amount to 1.174 tons/year, and 1.814 tons/year at DBH-2.

Altogether current pollutant emissions from district sources for residential area heating amount to 119.926 g/sec (221.862 tons/year) with the use of gas and 604.102 g/sec (1,071.081 tons/year) with the use of mazut. Emissions of district boiler-houses pollute the air mainly with sulfur dioxide which maximum concentration is 1.06 MPL. Among district heating sources in Andijan, "Sever" DBH operating with the use of mazut is the main source of sulfur dioxide pollution. If DHs use natural gas, the air is polluted with nitrogen dioxide which maximum concentrations are 0.43 MPL.

Surface water and its quality. Andijansay, Hutan, Jonarik, Hakan ditch (arik) networks, Hortum channel and salt-discharge canal are the main water arteries of the city. According to the observational data, water quality in monitoring sections for the last 5 years has been deteriorating due to hazardous substances discharged with wastewater.

Contamination index shows that water quality is classified as Class III – moderately contaminated water. Visual monitoring shows that these water channels are characterized with swift flow and low water transparency due to natural and man-made clayish suspensions; water color is grayish-green, its bottom is covered with blue-green algae and brown-gray crust that evenly cover stony substrates. Concentrations of almost all pollutants (except for copper) do not exceed sanitary norms. As to hydrochemical composition, the water is classified as Class II of clean water.

In terms of hydro-biological indicators, some water areas are recognized as satisfactory with higher levels of trophicity and self-purification due to intensive flowage and abundant aquatic biota, especially aquatic vegetation associations.

Water pollution from heating sources. There are no discharges from DBHs to surface watercourses. Saline wastewater from water treatment plants is discharged to the city sewerage system, its consumption amounts 317.85 thousand m^3/year. Potential groundwater impact sources given their aggressiveness towards concretes and high soil filterability include

DBH-2 underground containers for liquid fuel storage which have been operated for more than 20 years. Additional investigations are required to identify and liquidate possible leakages of oil products at DBH-2.

Ground waters. Andijan area is characterized by medium and low mountain block-wave terrain and belongs to the lowest terrace of the Akbur-Andijan alluvial cone. It is characterized by low water exchange in the groundwater. Tashkent State Engineering and Technical Research Institute monitoring data show that the groundwater maximum level is typically reported in May-June, and the lowest – in December-February. Groundwater depth should be estimated as 4.8 m. Chemical tests show that (according to construction rules and regulations 2.03.11-96) groundwater is non-aggressive to concretes and reinforced concrete constructions of normal density made of ordinary cement brands. As to its hydro-chemical composition, the water is hydro-carbonate-sulfate-magnesium, weakly alkaline.

Soil quality. Geomorphologically the city is located in the south-west of the oblast on the second terrace above the flood-plain of ancient deposits of the Shakhrikhansay River and is laid with alluvial-proluvial upper quaternary deposits – loam, sand and pebble stones. In geolythological terms, the area is formed by loess-like soils covered by 1.0-1.5 m of fill-up grounds. Fill-up grounds include deformed loamy soils with domestic and construction waste fragments. They differ from each other in terms of their composition, density and compressibility, and, thus, they are not recommended as a natural base. Fill-up grounds are widely used as a ballast layer of motorcar roads and pedestrian walkways and as filling of foundation pits, underground utility lines and buildings, for vertical land leveling and filling of spaces between floors and ceilings in formerly constructed buildings.

Groundwater of loose gravel deposits fully moistens their layer. The lower part of a loamy layer is permanently under capillary moistening of groundwater which results in salinity of soils and accumulation of soluble salts in upper layers as meadow gray soils are characterized by high reservoir qualities. The area soil salinity in terms of micro-component soil composition is of a sulfate type.

Geological structure. The first geological layer of the area is represented by filled soil and consists of deformed loam and clay sands with vegetation roots, pebbles and gravel (up to 15%, in some areas up to 40-45%). Area and depth of filled soil are extremely uneven with possible macro-cavities and soluble components. In some areas soils are not caked and have different composition and density and extremely different physical and mechanical characteristics. The second geological layer is represented by loess-like loam. Loam is macro-porous, its color varies from light to dark brown, it has sub-layers and fine sand lenses with solid and semi-solid sandy clays. It is collapsible under pressure of up to 0.3 MPa. Maximum thickness of this layer is up to 6 m.

Seismic activity in the city's area is 9 on the Richter scale.

Flora and Fauna. The area belongs to the Fergana biogeographical zone. Under zoogeographical classification by B. Kuznetsov, Fergana Valley belongs to the desert and steppe zone of Tamartica. There are a number of distinct biotypes with vegetation, animal associations and distinctive seasonal rhythms. The most common biotypes of the area include fields of various agricultural crops (mainly cotton), hardy-shrubs, water reservoirs, and buildings. Each biotype is inhabited with groups of animals and plants and constitutes bio-

cenosis. Vegetation communities are dominated by ephemeris sedge-bluegrass and ephemeris-sagebrush vegetation mixed with perennial plants; suffruticous bindweed, nectariferous plants (breadroot), Calligonum, labiates, *Haplophyllum suaveolens*, and *Artemísia scopária.* Some areas are inhabited with camel thorn, salt trees, and semi-shrubs – *Cousinia*, cornel, saltbush, *Phlomis*, *Psoralia*, etc.

There are also plantations of fruit-bearing and decorative trees (apple, cherry-plum, apricot, cherry, peach, plum, mulberry trees and planes, poplars, and Robinia trees). For animals, this vegetation (both trees and bushes) serves as their habitats and creates good protective and feeding conditions. Poplar, elm, sycamore, ash-tree and maple are very typical for this area. Out of foreign species, *Gleditsia*, *Ailanthus*, pagoda tree, mimosa, thuja are also common. There are many trees planted along the roads (such as plane tree, poplar, *Ailanthus altissima*, ash tree, maple, and less common thuja.) In terms of emissions produced by a road nearby the facility, polluted sites can be considered as agro-ecosystems that receive additional mineral fertilizers in the form of nitrates. The state of tree vegetation is satisfactory. Vegetation habitus, height and crown form is considered normal. Plant irrigation helps vegetation growth in this area. As the project facility is located in densely populated area of Andijan oblast, animal biodiversity is limited and fauna is mainly represented by rodents (field mice, house mice, and gray rats), birds (rooks, jackdaws, gray crows, robins, sparrows, mynas, doves, etc.), and household animals (cattle, sheep, and poultry).

Public Health. Public health assessment was based on statistical data of the RUz Ministry of Health, and some local nosological data for the last five years were averaged in comparison with the average national data (*Table 4*).

Table 4. Morbidity Rate, per 100,000 people

Disease	*Andijan oblast*	*RUz*
1. Tumors	73.6	71.0
2. Endocrine diseases	3,508.4	2,449.9
3. Blood and hemopoietic organs diseases	9,796.8	7,347.3
4. Mental disorders	353.8	267.2
5. Congenital abnormalities	31.9	60.8
6. Disease of blood circulation system	972.0	1,201.9
7. Respiratory diseases	10,914.0	11,889.5
8. Diseases of the digestive system	6,569.3	5,278.0
9. Urogenital diseases	2,689.0	2,280.3
10. Skin diseases	1,899.6	2,335.7

The morbidity rate of respiratory diseases among children in Andijan oblast is higher than in the other nosological groups, but lower than the average national rate. They are followed by blood diseases, diseases of the digestive system, endocrine and urogenital diseases. The average rates of respiratory diseases, blood circulation diseases, disease of digestive system, skin diseases, and congenital abnormalities in Andijan oblast are lower than the national rates. At the same time, the national morbidity rates are lower than the ones in Andijan oblast for the following diseases: tumors, endocrine diseases, blood and hemopoietic organs diseases. Blood and hemopoietic organs diseases are the second most common diseases followed by diseases of digestive system, neurological and urogenital diseases, and skin diseases. In general, morbidity rates in Andijan oblast in terms of dominants of nosological groups are similar to the national indicators. In the city of Andijan, the most common diseases include

respiratory diseases, neurological diseases, diseases of sense organs, and blood circulation diseases. The rates of respiratory diseases, blood and hemopoietic organs diseases, infectious diseases tend to grow. For the last years, the growth rate of the above mentioned nosological groups was 7-12%. Higher rates of cold-related and infectious diseases in wintertime are directly related to insufficient district heating of multistory residential buildings. Thus, in accordance with "Guidelines for Environmental and Health Classification of RUz Territories in Terms of Their Hazard to Public Health", this area is considered as an area with stressed environmental situation in terms of people's morbidity rates.

Current environmental assessment in Andijan oblast has revealed correlation between health status and air pollution. The highest indicators of a prevailing nosologic group – respiratory diseases – may be related to higher concentrations of sulfur dioxide and a social factor - insufficient heat in premises in wintertime which results in higher rate of respiratory diseases.

3.1.3. Analysis of project alternatives

"Zero option" and centralized versus decentralized heating supply alternatives. In case of abandoning reconstruction and modernization of Chirchik heating system it will deprive the population in Andijan of the opportunity to receive heating and thus zero option has been rejected.

As described above, the main role in district heating was performed by two district boiler-houses – "Sever" DBH and DBH-2. Major part of their equipment has been operated for 25 years. First boiling equipment was put into operation in 1979, i.e. most energy equipment is overage. Furthermore, operation of outdated equipment requires large financial, physical and labor expenses for extensive repair and maintenance. In addition, existing equipment consumes too much fuel and does not comply with nowadays environmental parameters. Existing district heating system in Andijan cannot ensure heat comfort for residents of multistory buildings due to exhausted heating networks. Average heat losses account for 10%, and residents of Microdistricts 3, 4, and 5 and Kusharik practically do not receive heat. Thus, the higher need in heating and impossibility to fully use the BH outdated equipment requires reconstruction of city heat-supply facilities. Introduction of decentralized heating for heat consumers is one of the promising ways to solve this problem. Taking this into consideration, under the project have been also considered the alternatives of centralized and decentralized heating supply by providing heating to all heat consumers in Andijan – 701 multistory residential buildings and 65 public buildings – with the use of module mini boiler-houses of a container type. The second option would require construction of 210 mini boiler-houses, including:

- with capacity up to 300 kW (0.26 Gcal/hr) – 31 mini BHs;
- with capacity up to 500 kW (0.43 Gcal/hr) – 46 mini BHs;
- with capacity up to 1,000 kW (0.86 Gcal/hr) – 31 mini BHs;
- with capacity up to 1,500 kW (1.29 Gcal/hr) – 53 mini BHs;
- with capacity up to 2,000 kW (1.72 Gcal/hr) – 49 mini BHs.

Mini boiler-houses are operated automatically and aim to boil water for providing heat and hot water to one or several multi-apartment or public buildings. They are supplied together with required supporting equipment and automatic devices. The option to ensure heat coverage of all consumers with the use of mini BHs of a container type has the following advantages: (a) decreased heat transportation losses as a heating source is located close to

consumers and the length of main heating networks are much shorter; (b) less expenses for maintenance and operation of the main heating networks. At the same time, apart from the above advantages, this option has the following drawbacks compared to centralized district heating:

- lower fuel efficiency – due to lower boiler's capacity, its efficiency factor also decreases; the lower the boiler's capacity, the lower its efficiency factor;
- more works to construct engineering networks for water supply, power supply and heat supply due to a significant increase in a number of heat sources with low capacity;
- difficulties in finding sites for mini BH construction in densely populated areas with a lot of multistory residential buildings and in preserving aesthetics of yards in residential areas;
- more maintenance personnel of a heat-supply organization, inconveniences in BH maintenance as technical personnel should periodically visit far-located facilities.

Comparison of advantages and disadvantages of these two options shows that district heating from mini boiler-houses is more suitable for residential areas with compacted location of multistory residential buildings, while mini boiler-houses with low capacity would be better for heating of residential and public multistory buildings located far from compact residential areas. Based on the above findings, it was decided to apply district heating for compact micro-districts of multistory residential buildings from district and local boiler-houses, and decentralized heating of residential and public multistory buildings located far compact residential areas – with the use of mini boiler-houses.

Another two project alternatives were with regard to use of natural gas or brown coal as energy resources. Currently the natural gas is a primary fuel for boiler-houses in Andijan. Its annual consumption calculated on the basis annual heat consumption by consumers is 79.821 million cubic meters. To ensure reliable gas supplies of boiler-houses, it is planned to construct a gas pipeline of high and moderate pressure from "Buston" automated gas distribution station to the "Sever" district BH-1 which length will be 10.87 km, diameter – 219~426 mm.

Brown coal from the Angren deposit is considered as alternative fuel. It has the following qualities (according to "Ugol" JSC data) (see *table 5*):

Table 5. Brown coal data

Coal quality	Balance-1	Balance-2
Lower calorific value (kcal/kg)	2,700	2,200
Fuel moisture (%)	40	40
Ash of dry coal (%)	35	60
Ash of as-fired fuel (%)	21	36

It should be noted that coal quality is getting worse compared to the above indicators and coal calorific value varies from 1,800 to 2,200 kcal/kg. Estimated coal consumption given its lower quality is supposed to be 380.8 thousand tons per year with approximately 145 thousand tons of ash and cinder waste. Coal burning boiler-houses has the following disadvantages compared to natural gas burning:

- It is necessary to extend the area for boiler-house construction and ensure extra sites for cinder disposal area;

- After solid fuel is burned, cinder waste is left which largest part (furnace cinder) is accumulated in the boiler furnace and removed through cinder hoppers;
- Small particles (ash) are emitted with flue gases and in most cases are caught by dust collectors and accumulated in cinder hoppers. Some ashes vanish in the air. Ash and cinder removal and their piling in special dumps is an important issue. Boiler-houses fired by solid fuel must have a cinder treatment unit, including fly-ash collectors and cinder bunkers, and equipment for treatment and moving of cinder waste within a boiler-house, outdoor cinder removal and area for this waste stockpiling.
- Construction of specific-purpose facilities for coal burning: coal storage house, fuel delivery system, coal treatment system before its burning, ash collector, ash and cinder removal system and cinder dump;
- It makes an equipment technological scheme and its maintenance more difficult;
- It results in personnel growth, higher maintenance and repair costs, and production cost;
- It results in much more air and environmental pollution (CO_2 emissions) compared to the use of gaseous fuel;
- It requires extra costs for railway transportation of Angren coal.

While comparing these two alternative options, there were also estimated boiler-house emissions in the case of use of Angren brown coal and of natural gas. The results of the estimations based on coal use are presented in the *table 6* while of natural gas – below in the next section.

Table 6. Estimated emissions for the case of usage of brown coal

Substance	MPL	Quota (Andijan)	Hazard classification	Total emission (tons/year)
1. Carbon oxide	5.0	0.33	4	1,220.94
2. Nitrogen dioxide	0.085	0.20	2	942.095
3. Coal cinder	0.3	0.25	3	5,087.234
4. Sulfur dioxide	0.5	0.25	3	2,038.413
Total:				9,288.682

To determine impact of these emissions on the city air was used “Vega” software for computer modeling of air pollutant dispersion.

Maximum concentration of *carbon oxide* (0.16 MPL) from heating sources in the city area will be registered in the DBH-1 area (X 16940, У 20020) which does not exceed the emission quota (0.33 MPL). It is necessary to regularly control technological equipment and ventilation systems to keep emissions at the same level.

Maximum concentration of *nitrogen oxide* (7.27 MPL) from heating sources in the city area will be registered in the DBH-1 area (X 16940, У 20020) which exceeds the emission quota (0.20 MPL). Concentration in the DBH-2 area is 4.66 MPL, concentrations in the area of local BHs will vary from 3.87 to 1.87 MPL, i.e. emission quota exceededing in all areas affected by heating sources.

Maximum concentration of *coal cinder* (16.39 MPL) from heating sources in the city area will be registered in the DBH-1 area (X 16940, У 20020). Concentration in the DBH-2 area is 8.47 MPL, concentrations in the area of local BHs vary from 6.76 to 3.03 MPL, i.e. emission quota is exceeding virtually in all city areas. It should be noted that emission concentrations were computed with an assumption that cinder collectors are used.

Maximum concentration of *sulfur dioxide* (2.67 MPL) from heating sources in the city area will be registered in the DBH-1 area (X 16940, У 20020). Concentration in the DBH-2 area is 1.71 MPL, concentrations in the area of local BHs vary from 1.42 to 0.69 MPL, i.e. emission quota is exceeded in all areas affected by heating sources. It should be noted that emission concentrations were computed with an assumption that cinder collectors are used.

Based on the computations, the following conclusions can be made: *use of Angren brown coal as alternative fuel would have an extremely negative impact on the air in Andijan. Development of measures to reduce air emissions is unlikely to be sufficient.*

3.1.4. Impact Assessment

Project impact assessment was conducted for three major types of civil works that will be done under the current project: (a) construction and operation of BHs; (b) construction of natural gas supply pipeline; and (c) construction of mini-boilers.

A. Potential impacts in the results of construction and operation of BHs

<u>*Air pollution.*</u> Annual natural gas consumption (calculated on the basis of annual heat consumption by consumers) after the project implementation amounts to 79.821 million cubic meters. The overall emissions from all sources are presented in the Annex 2. To determine impact of air emissions from these sources, "Vega" software was used for computer modeling of air pollutant dispersion. Based on the computations, the following conclusions can be made:

Maximum concentration of *carbon monoxide* (0.095 MPL) from heating sources in the city area is registered in the DBH-1 area (X 16940, Y 20020) and does not exceed the emission quota (0.33 MPL).

Maximum concentration of *nitrogen oxide* (2.25 MPL) from heating sources in the city area is registered in the DBH-1 area (X 16940, Y 20020) and exceeds the emission quota (0.20 MPL). Concentrations of this substance released by DBH-2 and local boiler-houses are also above the emission quota.
Maximum concentration of *benzapyrene* (0.0029 MPL) from heating sources in the city area is registered in the DBH-1 area (X 20020, У 15400) and does not exceed the emission quota (0.17 MPL).
Maximum concentration of *sulfur dioxide* (0.046 MPL) from heating sources in the city area is registered in the DBH-1 area (X 16940, У 20020) and does not exceed the emission quota (0.25 MPL).

Provided data show use of natural gas will not exeed the MPL in the case of most of pollutants but nitrogen monoxide and in this case the project has to provide clear measures to reduce their emissions (see next section).

<u>*Water pollution.*</u> Prior to reconstruction, annual water consumption by "Sever" DBH is 1,000 thousand m^3, and 1,500 thousand m^3 by DBH-2. In case of accidents of heat supply pipelines, water consumption increases by 100 thousand m^3 at "Sever" DBH and by 150 thousand m^3 at DBH-2. Municipal water distribution network is a source of BH water supply. Raw piped water does not meet water requirements for heating equipment. Water hardness to feed

heating networks and water heating boilers shall not exceed 0.05 mg-eq/dm^3. Caption exchange method applies to water treatment equipment which ensures quality of feed water in accordance with a 150 - 70°C temperature regime. Na^+ - caption-exchanging filters are regenerated with salt and salt-containing water is discharged into the municipal sewerage system. Annual wastewater discharged from "Sever" DBH to the municipal sewerage system is 127.85 thousand m^3, and 190.0 thousand m^3 from DBH-2.

Measures to reduce above-norm water feeding of heating networks caused by leaks and uncontrolled discharges from main and sub-main networks and consumers play an important role in reducing discharges from BH water treatment equipment. Reduction of excessive discharges contributes to less water feeding of networks and less treatment reagents, and subsequently reduces mineralized discharges from water treatment equipment. Under the project, a system of connecting buildings to heating networks includes the following types of works:

- Reconstruction of in-house heat and hot water supply networks;
- Construction of heat substations with heat exchangers in each building heated by DBH-1, DBH-2, and local boiler-houses;
- Replacement of in-house vertical heat piping with horizontal piping;
- Construction of new pipelines in residential buildings for hot water supply, installation of metering devices;
- Installation of heat metering devices, thermal regulators and thermostatic valves.

Since cold water heated for the use in a hot water supply system is not purified, it is necessary to use corrosion-resistant pipes for hot water supply inside buildings. As heat substations will be installed in the basements with a limited space, it seems reasonable to use compact and more efficient plate heat exchangers. If possible, hot water storage tanks with electrical heaters might also be used.

New boiler-houses will treat water with the use of scale inhibitor which in comparison with the current boiler-house practices of treating water with Na-caption filters will sharply reduce the use of reagents, water for BH needs (mainly for filter regeneration), electricity, labor costs for BH maintenance, and will virtually eliminate regeneration water discharges from water treatment equipment. Boiler-house wastewater will be discharged under gravity through in-house sewerage networks to sub-main sewerages of micro-districts. In-house sewerage networks are constructed of plastic pipes "HOBAS-TAPO" (diameter of 200-400 mm), the network (building drains where in-house pipes are connected to sewerage systems) provides for an inspection manhole (1,000-mm diameter) made of precast units. Wastewater discharge rate is 4.5 m/day (1.715 thousand m/year). Wastewater composition is characterized as domestic waters.

The collected rainwater after preliminary treatment is discharged through open reinforced concrete flumes to the city irrigation system. In accordance with the approved treatment arrangements, precipitation is collected in flumes of the irrigation system and then enters a gulley for local purification. Water is purified in technological containers with a pumping unit. First of all, light floating impurities (oil products) are separated from dirt-containing wastewater with the use of a semisubmersible board. Floating substances are collected from the water surface in flumes and then are passed through a pipeline to a portable container (to remove oil products) installed in a well near the unit. Dirt-containing wastewater under the bottom edge of a semisubmersible board flows into the next horizontal basin. Settled dirt is

accumulated in a pit and then manually collected when the units are emptied in dry season. Purified wastewater passes through filters into a chamber where a GNOM pump is equipped to pump purified water into a city irrigation network. Measures taken under the project will eliminate wastewater discharge into soil and surface waters.

Construction traffic. Transportation activities during the proposed civil works could lead to traffic congestion and inconvenience to the public due to: (i) increased vehicles for materials and solid wastes transportation, and (ii) deterioration of the roads condition after asphalt milling and excavation and leveling. It might bring negative effects to the narrower road and cause larger vehicle flux.

Noise and vibration impacts. Main noise sources of heating plants include smoke extractor plants, gas flues, and forced draft blowers. Pumping and blowing equipment are the also noise sources of the entities discussed in this document. Noise standard parameters are established by construction norms and regulations (2.01.08 – 96) – "Noise Protection" (see *table 7*):

Table 7. Noise standards

Indoor and Outdoor	*Medium frequencies of octave bands (Hz)*								*Noise level (dBA)*
	63	125	250	500	1000	2000	4000	8000	
	Sound pressure levels (dB)								
Rooms in apartments, vacation houses, dormitories	55	44	35	29	25	22	20	18	30

The projected city heating facilities will have the following noise and vibration sources (*table 8)*:

Table 8. Project noise and vibration sources

Equipment	*Medium frequencies of octave bands (Hz)*								*Noise level (dBA)*
	63	125	250	500	1000	2000	4000	8000	
	Sound pressure levels (dB)								
Electric engine	78	80	84	85	85	84	80	80	81

Based on the data received, estimated noise in residential areas is 12 dBA which is much lower than normative standards and there is no need in additional measures to reduce noise in residential areas.

*Waste generation***.** Boiler-house waste includes solid waste (scrap, metal cuttings, and electrode waste), oil waste (lubricants, and machine oil), oiled rugs and domestic waste. Quantity of industrial waste during repair works will be determined on an actual basis. Ferrous metal waste will be transferred to "Vtorchermet" for reprocessing. A metal container (capacity of 1,0 cubic meter) will be provided on every site for domestic waste collected during the area and boiler-houses cleaning. During construction works, construction waste will be accumulated as solid waste. Construction waste and domestic waste are planned to be transported to cities' landfills while oil wastes will be recycled and the ultimate wastes will be buried at the Andijan chemicals landfill. Domestic waste quantity is calculated on the basis of 3 employees with a domestic waste normative of 83 kg per 1 person/year – according to the Sanitary Regulations and Standards #0068-96: 3*83=249 kg/year or 0.249 tons/year for a boiler-house and 1.99 tons/year for all new boiler-houses.

Impacts on soil. The project provides for the use of 0.5-m fertile soil layers (removed during underground works) for planting of trees and shrubs. When trees and shrubs are planted into pits, removed soil will be replaced with fertile soil up to 50%. For flowerbeds, soil will be replaced with a 40-cm fertile soil layer. 10-cm humus layer is added for flowerbeds. All vegetation in the area of sites for BH construction will be preserved.

In operating boiler-houses, waste mercury lamps will also be accumulated which requires special measures for their proper storage. After that the lamps will be shipped to SELTA – an Uzbeck specialized private company for further demercurization.

B. Potential impatcs of the gas supply construction

Environmental impacts of the gas pipeline to be constructed will include: chemical substance emissions, soil integrity damage, damage to ecosystems along collectors, and land removal.

Soil impacts. Soil impact includes soil damage due to excavation works, electrochemical corrosion, and chemical pollution of surface layers. During construction works, surface soil will be mechanically damaged, temporarily removed for trench construction and permanently removed for a gas distribution substation. Soil damage will affect cultivated land. Soil structure will be damaged only in open spaces – tillage and wasteland plots near the terrace edge and some soil fragments near Andijan-say. The area of mechanically damaged soil of tilled and wasteland plots and along collectors will be 2,500 m along 2.5 km of the pipeline. About 34 m^3 fertile soil layer will be temporarily removed and restored after the completion of construction works. The allotted site for a gas distribution substation - 13 m (3.5*3.6) will be located in the road zone - 8 m far from the road in accordance with construction norms and rules.

Installation of supportive pillars in the area where the GDS site crosses the Andijan-say River will physically impact soil which will change its integrity and homogeneity, physical and chemical qualities – no pillars will be installed in the river bed as the width of the river is up to 10 metres. Chemical contamination is caused by road and construction equipment. Gas pipeline construction will change soil collapsibility, especially when soil is moistened with air or telluric water. At the stage of gas pipeline operation, there will be no permanent chemical substance discharge. The gas distribution substation with RDG-80 (gas pressure regulator) will be the only source of major potential blowouts. Pipeline will cause electromechanical corrosion of soil, surface water, and groundwater. This process is the most intensive in water-saturated or periodically moistened soils. Pipeline sections nearby power transmission lines will spread corrosion caused by ground current. Electro-chemical protection is provided for the gas pipeline to protect pipes from corrosion and ground current.

Groundwater impact will be minimal or absent as pillar foundation in the area of crossing the Andijan-say River does not reach the depth of groundwater. It will be impacted only in cases when the groundwater level goes up because of the penetration of air moist due to infiltration of irrigation water in agricultural fields and private lands located uphill. There will be no irreversible groundwater consumption and pollutant discharge into groundwater during gas pipeline construction and operation.

Surface water of the Andijan-say River will be not impacted during construction works as no pillars will be not installed in the river bed.

During construction works, *oil and lubricants* from the road and construction equipment used for construction of pillars and gas pipeline only accidentally may get into the Andijan-say's surface water.

Vegetation impact will include vegetation destruction and mechanical damage by road vehicles along the construction line close to the gas pipeline. Impact on synanthropic organisms and semi-aquatic ecosystems will include various disturbance factors due to construction noise and reduction of food resources for cattle and sheep. According to project safety requirements, the gas pipeline should be constructed 100 m far from residential areas.

Air impacts. Gas distribution substations will release natural gas together with associated substances - hydrogen sulfite and mercaptans. Emissions are qualified as burst releases. Due to poor tightness of GDS equipment, gas permanently releases into the air. Gas leaks from the RDG-80 plant should be 0.00000186 m^3/sec or 0.0067 m^3/hr according to "Guidelines for Determining Natural Gas Release Rate When Operating Gas Regulation Substations" ("Neftegaznauka" Scientific Development Association. Uzbek R&D Institute of Oil and Gas, Tashkent, 1995, p. 18.). Daily gas rate released by gas regulation stations will be only 0, 16 m^3. Methane releases will be 0.12 g/sec, hydrogen sulfide – $8.33*10^{-7}$ g/sec, and mercaptans – $3.5*10^{-6}$ g/sec. According to the calculation, in case of insufficient releases due to operational gas leaks, methane and related substances concentrations will be significantly less than 0.1 MPL outside the GDS. Single gas release from GDS is registered during GDS routine seasonal maintenance and adjustment. Gas release duration is 2 minutes, and 20 minutes in case of an accident. Volume of GDS gas release in case of emergency gas discharge from supply and return gas pipelines in the section between shut-off devices will be 7.67 m^3 under pressure of 0.54 MPa or 5.4 kg/cm^2. Gas volume per second will be $3,450*10^{-4}$ m^3/sec. Gas is released through gas flare with a diameter of 0.08 m, height of 1.5 m. In such cases, gas release velocity is 6, 87 m/sec. For a single gas release, total methane emission is $3.0* 10^{-2}$ tons/year (or 24, 9 g/sec). Air gas emission is accompanied with hydrogen sulfide – $2.1*10^{-7}$ tons/year (or 0.000173 g/sec). Mercaptan sulfur in the total gas emission is $8.7* 10^{-7}$ tons/year (or 0.000725 g/sec) provided that mercaptan sulfur concentration in natural gas is 11 mg/m^3. The above calculation proves that single releases are much stronger than permanent leaks. They are qualified as accidents and occur once a year.

C. Potential impacts of construction of mini-boilers, installation of Individual Heating Stations and old heating pipes replacement

Associated with mini-boilers construction works may have environmental impact during transportation of materials and equipment, site cleaning and preparation, foundation construction, equipment installation, pipes replacement and putting facilities into operation. Major types of environmental impacts include the following: (a) Air impact due to operations of construction equipment and transportation vehicles; (b) Soil impact – its mechanical damage due to excavation and leveling works, and foundation construction; (c) Soil and groundwater impact due to spillages of oil products used as fuel for motor vehicles and construction equipment; andf (d) labor safety issues.

In addition, construction workers will experience noise and vibration impact during operations of construction equipment. Dust and exhausts from construction equipment will pollute the ambient air. The above types of impact can be kept at permissible levels, provided that construction norms and regulations are observed.

Material and equipment transportation. Environmental impact caused by materials and equipment used for construction and assembling works includes the following: heavy equipment and trucks entering and leaving the site; unloading of bulk materials such as sand; storage, workmen's shelter, and office construction; stockpiling of construction and installation materials. All materials and equipment required to construct boiler-houses, gas pipeline and external power supply facilities will be transported to the site by cars. During and after construction, domestic and industrial waste should be transported from the area of boiler-houses, gas pipeline, and external power facilities.

Site cleaning and leveling. Sites selected in microdistrict areas for construction of new boiler-houses are relatively plain and free from trees and shrubs. There is no vegetation to be cut down even along gas pipeline routes and 6-kV cable lines. It is expected to add some soil on a part of the selected site to properly locate and operate construction facilities and ensure architectural integrity.

Equipment installation. General contractor will be assigned and terms and conditions of all required contracts will be agreed to ensure safety and proper execution of construction works, including assembling and installation. Soil under building foundations will be compacted. Therefore, foundation depth should vary depending on initial soil density and its further compaction.

Commissioning. Prior to commissioning/putting into operation of new boiler-houses, their operations, fuel and water supply, fire, ventilation systems, and all respective services should be pre-inspected and pretested.

Air quality impact. Air in the construction site is expected to be polluted with dust during construction works. Dust will be accumulated during excavation works and unloading of bulk materials (sand, gravel, and crushed stone). If a cement mixing unit is used on the site, it might be another source of dust. Dust amount caused by construction equipment (bulldozers, excavators) on the site will depend on frequency of construction works, necessity of specific works, weather conditions, and soil qualities. In most cases, such construction works as soil extraction for foundations are temporary. Dust formed by excavation and transportation works mainly consists of large quick-settling particles and, therefore, in most cases it does not spread outside the site. Adherence to construction norms, sprinkling of roads and soil piles, and other construction materials, speed limits for transport vehicles on the site will lessen dust spread. Ambient air will also be polluted with exhausts from trucks and construction equipment due to gasoline and diesel fuel combustion. Besides, the air will be polluted with welding aerosol, manganese compounds from welding works, vapor of organic solvents, paint and varnish aerosols during painting works, and timber dust during woodworks.

Water quality impact. During construction works there is a low risk of discharging of excavated soil and waste from construction works into surface water and thus water might be polluted.

Soil and groundwater contamination. During construction works, soil might be contaminated with spillages of oil products used as fuel for trucks and construction equipment. However, such type of pollution will be insignificant and local. Fire risk due to fuel spillage is also low. In general, soil and groundwater contaminated with oil products will present low risks for environment and personnel health safety.

Noise and vibration. The following construction works will produce noise: (a) Foundation construction and concrete mixing; (b) Assembling of steel construction units and installation of equipment; (c) Site cleaning and putting boiler-houses into operation. Typical noise levels 15-m far from construction equipment at the first two stages of construction works are presented in the *table 9*.

Table 9. Typical Noise Impact during Construction Works

Equipment	*Maximum level of expected noise 15-m far from construction equipment (dBA)*
Cement mixing units	87
Cranes	86
Paint spray diffuser	89
Excavators	90
Welding units	73
Dump trucks	87

Site cleaning works should be relatively quiet, and equipment commissioning noise should be lowered by antinoise measures. All most noisy construction works, and soil reloading works in particular, should be performed in daylight time. Therefore, this temporary noise will not significantly affect residential areas.

Thus, construction-related noise will be temporary and insignificant and will not exceed noise standards.

Waste and excavated soil piling and disposal. Construction works will produce the following types of waste:

- Waste pipes;
- Waste insulation materials, lamps and steel framework fragments, bricks and cement, electrical parts, lubricants and oils, paints and dissolvents;
- Waste glass, merchant waste and unusable items.

Non-contaminated waste will be transported to city landfill. Besides, there might be excavated soil on the site. Upon completion of construction, the removed soil will be reused for the site land leveling and BH area improvement works.

3.1.5. Environmental Mitigation Plan

Mitigation of environmental impacts will include the following.

Measures to reduce air pollution. Based on computation made to detect emission source impact due to reconstruction works, it could be concluded that emission concentrations of all substances but nitrogen dioxide will not exceed the quotas established for the use of natural gas as fuel. Nitrogen oxide emissions can be reduced by reducing or liquidating "thermal" NO_x. This will be achieved by lowering maximum burning temperatures – recirculation gas, water and steam injections into a burning zone or forced air flow, and through two-stage fuel burning which lowers maximum temperature and oxygen concentration in the zone of maximum temperatures and will be done by purchasing new and very efficient gas burners which allows fully eliminate "thermal" NO_x by changing nitrogen oxide concentrations to the prompt NO_x or to 100-120 mg/m^3 in cold air and to 150-200 mg/m^3 in hot air.

Water resources protection measures. With a view to protecting and preventing groundwater contamination and ensuring health and disease control in accordance with construction norms and regulations 2.04.02.-97 and SS 245-71 "For Waterworks", a series of measures are provided to eliminate risks of soil and groundwater contamination with domestic, fecal, and industrial discharges from the facility: (a) use of equipment, reinforced frames and pipelines resistant to corrosive effects of waste and underground water; (b) hydro-insulation for sewerage and water wells, chambers, and containers; and (c) antiseismic construction units. Underground unit concrete is made of sulfate-resistant Portland cement. Outer surfaces of such units in touch with soil are double coated with hot bitumen. Strict control over tightness of the elements of water distribution networks could suffice to fully eliminate groundwater impact in the site area.

Measures to reduce noise. Technological equipment and electric engines of pumping and ventilation equipment are the main sources of noise at the project site. It should be noted that in the process of project development it is necessary to provide for standard equipment that meet GOST 17770-72 requirements (vibration and noise reduction devices) and GOST 12.4.011-75 (vibration-isolating and absorbing devices). Fan equipment should be located in separate premises on a resiliently supported base; system joints should be equipped with flexible connectors. It is possible to assume that project facility operation will have no significant noise impact in the area of its location.

Waste management. To store waste and obsolete fluorescent lamps, the project should provide for a separate room equipped with an exhaust ventilation system which capacity per hour should be at least 10 times higher than the room space. Lamps should be stored in boxes; in addition, each lamp should be stored in an individual package made of corrugated cardboard. As this type of waste belongs to mercury-containing waste, it should be collected, stored, registered and transported in accordance with O'z RH 84.3.10: 2004 "Regulation on Handling Procedures for Mercury-containing Products in the Republic of Uzbekistan" and should be safely disposed with ultimate demercuration at SELTA entrprise. For efficient collection and storage of rubbish and domestic waste, the project shall provide for a separate site equipped with improved covers and special containers with a capacity enough for a 3-day waste, and control its timely transportation by utility service's special trucks. It shall be strictly prohibited to burn solid waste.

Boiler-house waste (scrap, metal cuttings, and electrode waste), will be transferred to "Vtorchermet" for reprocessing. For domestic waste to be collected a metal container (capacity of 1,0 cubic meter) will be provided on every site during the area and boiler-houses cleaning. Construction waste and domestic waste are planned to be transported to cities' landfills.

Soil protection during earthworks. A number of leveling measures shall be provided to put facilities into operation and to cover the replaced pipes: the facility site shall be leveled so as to ensure flow of rainwater into an irrigation network and eliminate the risk of washouts, water logging, and flooding of nearby areas. Area around buildings and facilities should be covered with an improved asphalt coat (5-cm thick) above a 10-cm layer of black crushed-stone. During construction of new BHs, it shall be provided to remove at least 10-cm fertile soil layer with its further use for planting trees and shrubs. Areas free of BH facilities should be efficiently planted with greenery, and afforestation belt outside the site should be arranged. Also a series of measures shall be provided to protect and prevent soil from contamination on

the project site in accordance with GOST 17.4.3.02-85 “Nature Protection. Soil” and GOST 17.5.3.06-85 “Nature Protection. Land Plots”: Traffic should move only along constructed roads that ensures safe traffic environment and does not cause vegetation and soil damages.

Measures to reduce environmental impact caused by accidents. Major environmental impact of new boiler-houses, their gas and power supply systems will be associated with accidents. Environmental risks will be much higher in case of accidents associated with inflammable fuel (natural gas), heat supply pipeline accidents, gas pipelines and 6-kV cable lines, i.e. existing and new boiler-houses have the same causes and scenarios of accidents. Nevertheless, the risk of accidents at new boiler-houses is much lower than at the existing DBHs due to measures provided under the project.

Boiling plants in hew boiler-houses will be equipped by fuel burning automatic control devices. Boiler-houses will also be equipped with fire alarm systems in accordance with state standards that provide for receiving fire location and time alarms, address instructions for controlling fire alarm systems, and alerting people.

In cases of fire, automated fire alarm systems provide for activation of emergency smoke ventilation, deactivation of ventilation and technological equipment, and fire pump start-up. Each boiler-house shall have a water reservoir with a capacity of 100 m against fire accidents. To prevent accumulation of low-soluble salt in a heat supple system which results in failures of heat pipelines, the project shall provide for measured use of scale inhibitor to treat feed water. This will enable to eliminate another cause of accidents periodically occurring in boiler-houses when spillages and leakages of salted water from regeneration of Na-cation filters are discharged in a sewerage system and may contaminate soil and groundwater. The use of scale inhibitor prevents industrial discharges at new boiler-houses. Introduction of a double-pipe closed heat supply system and the use of steel pipes covered with polyurethane foam and plastic insulation by a manufacturer reduce accident risks which allows to ensure efficient and uninterrupted heat supply to consumers, reduce fuel and water consumption to cover accidental losses.

The following factors reduce gas pipeline accident risks: reliable construction of a line pipe, underground construction of pipes, use of steel pipes, gas pipeline corrosion-resistant insulation and electrochemical protection, and 100% joint radiographic control. To avoid accidents of power transmission facilities, the project provides for reliable grounding of casings of all substations’ electrotechnical equipment, and power cable sheaths; use of fail-safe relay protection and automation devices ensuring prompt shutdown of damaged network sections and dispatcher’s access to current information.

Each source is associated with the use of one potentially dangerous substance or a group of substances and is localized, except for transport where some road sections might be potentially dangerous and, therefore, accidents are also localized.

Boiler-house’s personnel and people living nearby are potentially exposed to heat source accidents. In terms of danger assessment, maximum number of people present at the same time is reported in the areas adjacent to all new boiler-houses and existing DBHs. Moreover, the risk increases due to exhausted equipment commissioned in 1979. Assessment of environmental impact of potential accidents at city boiler-houses was performed on the basis of recommendations presented in “Guidelines to Assess Danger Associated with Potential

Accidents during Production, Storage, Use, and Transportation of Large Amounts of Inflammable and Toxic Substances."

A zone of irrevocable and health damages was defined for an accident with the highest number of casualties – gas pipeline unsealing (possible causes: metal fatigue, corrosion, poor performance of works, natural calamities, etc.) followed by fire and gas cloud explosion. This calculation includes quantitative characteristics of a gas pipeline: high pressure of 1.2 MPa, medium pressure of 0.3 MPa, diameter of 0.4 m. In case of fire, nitrogen, sulfur, carbon oxides, and soot concentrations due to gas burning will be over 10 MPL. Damage area will be formed as a concentric circle with the center in the place of gas leakage. Area radius depends on a gas pipeline diameter and is determined by the following formula:

y=a*x+b, in which a, b – coefficients corresponding to a health damage area: 105.3; and irrevocable damage area: 38.9; -1.7; x- diameter of a gas pipeline: 0.4 m. Thus, diameter of a health and irrevocable damage area will be: y_h=105*0.4+3=45 m and - y_i=38.9*0.4-1.7=13.86 m.

People in the fire area of 603 sq m (radius of 13.86 m) with the center in a fire source will suffer burns with 100% lethal outcome (irrevocable damage area); people in the fire area of 6,359 sq m (radius of 45 m) may need hospitalization (health damage area). Gas cloud explosion results in lethal damages for 100% people in the area of gas cloud, they will die from burns and asphyxia due to lack of oxygen. People close to the explosion center (10-100 m) will die from a shock wave and blasted debris. Health damage will cover the places where maximum excessive pressure of a shock wave is higher than 0.1 atm. Expected frequency of accidents depends on its scenario, safety type and operation intensity of an impact source. A priori frequency of the discussed accident is determined as 10^{-6} (mean value of accident frequency). Thus, accident risks at projected boiler-houses are much lower than at existing DBHs.

Construction traffic. In conjunction with the local traffic management authority, traffic flow regulation plans at project sites will be prepared before construction begins, if necessary. Proper transportation time and route will be selected to avoid rush hours and reduce traffic congestion.

Public Health and Safety. Health & Sanitation is a key public health issue during construction. Sanitation services will be maintained, including air quality, food quality and water supply. Medical first aid kits and health services will also be provided.

Safety requirements. To avoid accidents, it is necessary to comply with the following occupational safety requirements:

- Required safety devices for equipment;
- Isolation of equipment operated in high temperature mode;
- Fire safety system;
- Training of personnel on occupational safety;
- Providing of personnel with personal protective equipment.
- Boiler-houses use natural gas as a fuel that is flammable and highly explosive.
- In case of gas pipeline destruction, gas leak may cause fire. The following protects the line from corrosion:
- Gas pipeline is treated with primary coat and then painted two more times.
- Cutout, controlling and protective devices are installed before gas-consuming equipment.

- Gas metering and automation system are provided to ensure adequate processing conditions and safe operation.

Contractors will be required to take safety measures at the construction site to protect the workers and the public, including provision of appropriate personal protective equipment for workers and arrangement of warning signs to alert the public of potential safety risks in and around the construction sites.

The potential environmental risks during operation relate to accidental spills and leakage of wastewater. The regularly basic water tests will be done by the existing laboratory of district heating companies. Specific measures should be taken if any potential incidents or illegal discharge is found during regular inspection and maintenance. Standby equipment and pipes should be installed in such a way that will reduce the risk of accidental overflow. Furthermore, an emergency response plan for accidental water overflows or spills will be also prepared.

An operation and maintenance manual for equipment will be provided by the suppliers. The equipment operators and plant manager will be continuously trained in operational safety, maintenance of the facilities, emergency procedures and contingency plans will be prepared. Periodic training and practice sessions in safe operating procedures will be held during the DH system operation.

All mitigation measures along with the responsibilities are presented below in *table 10.*

Table 10. Mitigation plan

Process resulting in environmental impact	*Environmental impact features*	*Environmental impact duration Local/continuous*	*Measures to reduce environmental impact*	*Institutional responsibility for controlling implementation of safeguards*
1	2	3	4	5
Impact during reconstruction of the city heat and hot water supply system				
Reconstruction of existing district boiler-houses (DBHs)	Waste accumulated during dismantling of replaced equipment and construction units; air pollution during delivery and transportation of construction materials to the sites, welding works, concrete preparation works, and excavation works; noise as a result of working equipment; insufficient increase in water consumption – for personnel domestic and drinking needs; personal safety issues	Local – phase of construction works	Distribution of all wastes accumulated during dismantling of equipment and construction units among enterprises specialized in their disposal and storage; strict control over the use of motor vehicles and construction equipment in accordance with established standards; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	Management of a contractor engaged in reconstruction of DBH
Dismantling of local boiler-houses (BHs)	Waste accumulated during dismantling of equipment and construction units; air pollution during demolition and removal of equipment and construction units, and welding works during dismantling phase; noise as a result of working equipment; insufficient increase in water consumption – for personnel domestic and drinking needs; labor safety	Local – phase of construction works	Separation of all wastes accumulated during dismantling of equipment and construction units and their shipment to city landfill or to enterprises collecting ferrous wastes;; strict control over the use of motor vehicles and construction equipment in accordance with established standards; maintenance of the reconstructed sites – leveling, planting of greenery; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	Management of a contractor engaged in dismantling of a local BH
Construction of new local BHs	Possible demolition of buildings and tree cutting down in the construction sites; soil damage during construction site leveling; air pollution during preliminary site works and construction of local BHs; increase in water consumption; noise as a result of working equipment; labor safety	Local – phase of construction works	Selection of sites requiring minimum demolition and greenery cutting down for local BHs construction; soil removed during leveling works should be preserved during construction phase and used for planting of greenery on the site upon completion of construction works; strict control	Management of a contractor engaged in construction of a local BH

			over the use of motor vehicles and construction equipment in accordance with established standards; respecting labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	
Construction of mini BHs	Site leveling for mini BHs construction; welding works during equipment installation, water and gas supply system connection, and reconstruction of in-house heat and hot water supply networks; labor safety	Local – phase of construction works	Selection of sites requiring minimum leveling works for construction of mini BHs; involvement of highly qualified specialists to minimize consumption of welding materials; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	Management of a contractor engaged in construction of a mini BH
Construction of a high and medium pressure gas pipeline and submain medium pressure pipelines to projected BHs in residential areas	Insignificant impact during construction of gas pipeline pillars – excavation and welding works; insignificant soil removal for a gas distribution substation; emissions during installation (welding) works	Local – phase of construction works	Selection of the optimal route for gas pipelines; involvement of highly qualified specialists to minimize consumption of welding materials; providing of workers with uniforms, glasses, gloves, etc.	Management of a contractor engaged in construction of gas pipelines
Reconstruction of main and distribution heat networks	Emissions during dismantling of old heat networks (welding equipment, motor vehicles); new heat supply networks require trench works and installation of concrete beds – air pollution with fuel combustion products from equipment, dust emission; soil damage; possible cutting down of trees; emissions due to welding works during installation of pipelines; labor safety	Local – phase of construction works	Distribution of all wastes accumulated during dismantling of heat networks among enterprises specialized in their disposal and storage; strict control over the use of motor vehicles and construction equipment in accordance with established standards (during dismantling and construction works); selection of the optimal route for heat networks; involvement of highly qualified specialists to minimize consumption of welding materials; preserving of soil removed during pipeline construction for its further use for leveling.	Management of a contractor engaged in reconstruction of heat pipelines

Instalation of Individual Heating Stations	Emissions during civil works; construction waste generation; noise; air pollution with dust; labor safety.	Local – phase of civil works	Proper construction waste management; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc. .	Management of a contractor engaged in reconstruction of heat pipelines
Impact during operation				
Heat and hot water supply to consumers in Andijan	Air pollution due to operation of BHs; water consumption and contaminated water discharge; industrial wastes due to maintenance and overhaul of boiling equipment	Continuously – during operation	To reduce air pollution, the project provides for the use of new energy and cost efficient gas-fueled condensation boilers; water consumption and discharge will be reduced through the introduction of a closed heat supply system and construction of individual heating substations in residential and public buildings; distribution of all wastes accumulated during maintenance works among enterprises specialized in their disposal and storage; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	District heating company

3.1.6. Monitoring and supervision plan

In order to ensure efficient implementation of the mitigation measures proposed, including compliance with environmental requirements during the construction stage, a program of monitoring activities will be required (see it below in *table 11*). Inspections of construction sites are among the duties of the district heating authorities' staff and are covered form their budgets. The impact monitoring on water and air quality, noise, etc., will be done by Contractors and periodically by district heating company. Costs for monitoring activities during the Project construction phase should be included in the bill of quantity for proposed civil works.

Table 11. Monitoring plan

Project activity /Mitigation Measure	*Where* *(is the parameter to be monitored?)*	*What* *(is the parameter to be monitored?)*	*How* *(is the parameter to be monitored?)*	*Who* *(is responsible for monitoring?)*	*When* *(define the frequency / or continuous?)*	*Cost/sources of financing*
1	2	3	4	5	6	7
1. Reconstruction of existing boiler – houses (DBHs) / prevention of air pollution; waste management (collection, separation and disposal); ensuring labor safety through training and provided protective closes	Boiler-houses	Emissions/ dust, NOx; SO2; CO	Visual monitoring; Instrumental observations at the site	Contractor; DH company; State Committee for Environmental Protection	Daily for dust; Measurement of pollutants - before commissioning	Contract-based; Budgetary resources
		Waste/Waste weight and type and related expenditures	Data on collected, separated, transported and disposed along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract-based;
		Occupational safety/conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Constructor; District heating company	Monthly and based on the needs	Contract-based; District heating company operational resources
2. Dismantling of local boiler – houses (BHs) prevention of air pollution; waste management (collection, separation and disposal); ensuring labor safety through training and provided protective closes	Equipment room	Emissions/ dust	Visual monitoring;	Contractor; DH company;	Daily	Contract-based; Budgetary resources
		Waste weight and type and related expenditures	Contractor data on collected, separated, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract-based;
		Occupational safety/number of accidents; conducted specialized training, number of participants	Accident register; Training register; Expenditures for	Constructor; District heating company	Monthly and based on the needs	Contract-based; District heating company operational

		and provided protective closes	protective closes			resources
3. Construction of natural gas supply and replacement or exhausted pipelines of heat supply pipelines/ Soil protection; Prevention of air emissions from vehicles and equipment and watering for dust prevention; Noise prevention through calibration of equipment and working during daily time hours; Construction waste management – their collection, separation and disposal; Potential tree loses; Ensuring labor safety.	Pipeline route	Emissions/smoke from vehicles and working equipment; Dust; Expenditures.	Visual monitoring; Expenditures for watering	Contractor	Daily	Contract-based
		Soil protection/ volume of excavated and/or recultivated soil (m3)	Data on implemented works and on related expenditures	Contractor	Weekly	Contract-based
		Waste/type and weight; associated expenditures	Contractor data on collected, separated, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract-based
		Noise/level of noise in DbA	Instrumental measurements	Contractor; Sanitary inspection	Weekly	Contract based; District heating company resources
		Number of trees cut	Expenditures for tree cut	Contractor; District heating company	Monthly	District heating company resources
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources
4. Construction of new local and mini boiler-houses/ Soil protection; Prevention of dust and emissions from equipment; Noise prevention; Construction waste management; Potential tree loses	Project site	Emissions/dust and equipment emissions	Visual monitoring	Contractor	Once	Contract-based
		Waste/weight	Contractor data on collected, transported and disposed waste along with the data on expenditures for implemented waste management activities			
		Noise/level of noise in DbA	Instrumental measurements	Contractor; Sanitary inspection	Weekly	Contract based; District heating

Ensuring labor safety						company resources
		Number of trees cut	Expenditures for tree cut	Contractor; District heating company	Monthly	District heating company resources
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources
5. IHS construction / Prevention of dust and emissions from equipment; Noise prevention; Construction waste management; Ensuring labor safety	Residential buildings	Emissions/dust and equipment emissions	Visual monitoring	Contractor	Once	Contract-based
		Noise/level of noise in DbA	Instrumental measurements	Contractor; Sanitary inspection	Weekly	Contract based; District heating company resources
		Waste/weight	Contractor data on collected, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract based; District heating company resources
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources

3.1.7. State Ecological Expertise approval

The EIA&EMP for Andijan district heating project was submitted officially to the State Ecological Expertise of the State Committee for Environmental Protection for its review and approval. On October 17, 2014 such approval was issued (No. 18/1163) which states that the document fully corresponds to the national environmental requirements. The document also specifies the Andijan Oblast Committee for Environmental Protection has to keep under control implementation of prescribed in the EMP mitigation and monitoring measures.

3.2. EIA&EMP for Chirchik city

3.2.1. Current status of city's district heating system and proposed investments

Chirchik district heating enterprise "Issiklik Energiyasi" has 14 boiler-houses; out which 12 are operating and 2 have been stopped due to the lack of consumers. The main reasons for rejection of heating services are inadequate condition and physical deterioration of in-building systems and unjustified heat losses by heating pipelines. The company currently has the following technological facilities for its operations:

- "Ubileynaya" BH-1
- "OKBA" BH-2
- "Children's Hospital" BH-3
- "Maternity House" BH-4
- "Ak-kavak" BH-5
- "Municipal Hospital" BH-6
- "School 18" BH-7
- "School 10" BH-8
- "School 22" BH-9
- "Nijniy Komsomolsk" BH-10
- "Uzbekhimmash" BH-11
- "ChTZ" BH-12
- "Rudaki" BH-13
- "Microdistrict" BH-14
- UzKTJM BH-15-1
- UzKTJM BH-15-2
- UzKTJM BH-15-3
- Maxam Chirchik BH-16-1
- Local boiler-houses for 26 residential buildings
- Autonomous boiler-houses for 33 residential buildings
- Local boiler-houses for 5 social institutions.

Heating networks – both mains and submains - are constructed on high supports above ground and in reinforced concrete ducts under the ground. Due to physical deterioration and obsolescence of heating mains and in-house networks and above-limit system operation, heat and hot water consumption is higher than normative standards for heating-system water and power consumption. Total length of heating networks in Chirchik is 104.0 km, of which 46.11 km of underground networks and 57.89 km of above-ground ones; all of them require reconstruction (rehabilitation). Due to exhaustion of heating networks, feed water supply of district heating exceeds the normative – 1.54 times on the average. Exhausted in-house technical equipment and heat distribution pipes to apartments also result in excessive heat losses and do not ensure adequate heating of residential buildings required by heat normative parameters. Currently, a closed heat-supply system is used in Chirchik. This heating system has serious deficiencies:

- Excessive wear of pipelines and intensive scaling of consumer heating pipes;
- Excessive consumption of feed water and high costs of water treatment and leaks through shutoff and control valves;

- Leaks through heating riser-pipes (hot water discharge in the morning, especially when radiators are cold) in disadjusted systems and insufficient pressure differences at heat distribution stations;
- Unstable hydraulic control over heat consumption.

The heat-supply pipelines, heat-exchange equipment and heating surfaces of boiling equipment are insulated mainly with mineral wool, asphalted felt (ruberoid) and basalt fiber materials. All the above mentioned materials have serious drawbacks:

- Relatively short lifetime – 4-7 years;
- Low resistance and durability;
- Heat conduction losses.

According to prefesability study, the project provides for replacement 104.0 km of heating networks. It is also providing construction of 4 new local boiler-houses for 144 residential buildings supplied from UZKTJM and Maxam Chirchik BHs which length is 26.658 km. The length of heating networks from 12 local BHs to 26 and 33 residential buildings and 5 social institutions is 9.075 km. Projected heating networks will be constructed in underground crawlways. The total length of city BH pipes will be 139.773 km, of which 81.843 km of underground heating networks.

For insulation of pipelines and heat-exchange equipment, the project provides for the use of polyurethane foam – a unique synthetic polymer with the following qualities:

- Lowest conductivity coefficient;
- High chemical resistance;
- Protection of facilities from water, steam, rust, corrosion and resistance to microorganisms, mold, and decomposition.

Overall performance of the Chirchik heating system is very low; there were no repair works and extensive repair of exhausted main and distribution heating lines neither were there works to introduce energy efficient technologies or replace old equipment with the modern one. Besides, depreciation of in-house technical equipment and heating systems in multistory apartment buildings do not ensure residential heating according to effective normative parameters. Pipelines in basements and under the roof space of multistory apartment buildings are operated without thermo-insulation.

To improve quality and uninterrupted supply of heating to residential areas, as well as to improve cost efficiency of heat suppliers, it is planned to modernize Chirchik “Issiklik Energiyasi” and introduce new energy efficient technologies. Taking this into consideration the project will support the following works:

- Reconstruction and modernization of existing heat supply sources and networks;
- Construction of in-house individual heating substations with the use of modern energy and cost efficient equipment;
- Construction of 4 new boiler-houses for 144 residential buildings;
- Construction of 12 local boiler-houses for 26 residential buildings;
- Construction of autonomous boiler-houses for 33 residential buildings;
- Construction of 5 local boiler-houses for social institutions;

- Construction of solar collectors.

Total required number of solar collectors for hot water supply of the entire city is 31,845. Given the lack of vacant spaces at operating boiler-houses, the number of solar collectors should be limited and their number in each specific case should be calculated in accordance with the master plan of their location. As agreed with the customer, 4 boiler-houses with vacant spaces for solar collectors have been selected under the project (Ak-kavak BH-5, OKBA BH-2, Maternity House BH-4, and Nijniy Komsomolsk BH-10). Introduction and installation of solar heaters for hot water at operating boiler-houses will save natural gas and reduce air pollutant emissions.

After reconstruction and modernization and after construction of new boiler-houses the Chirchik "Issiklik Energiyasi" boiler-houses' capacity will be 304.354 Gcal/hr, of which 26.0 Gcal/hr due to the construction of 4 local BHs and 23.954 Gcal/hr (for comparison, current capacity is 278.14 Gcal/hr.) BH capacity will increase due to the construction of new boiler-houses. Reconstruction and modernization of boiler-houses will enable to completely improve the heating system, reduce consumption of natural gas and air pollutant emissions.

3.2.2. Baseline analysis

Area physiographic location and climate conditions. Chirchik is one of the largest industrial centers of Uzbekistan with well-developed industries: chemical, machinery and equipment, electrical engineering, energy, transport, and construction. The city is located in Tashkent region of the Republic of Uzbekistan, on the bank of the Chirchik River in a narrow mountain valley surrounded by offshoots of the Tian Shan Mountains. The valley is surrounded by the Tian Shan ranges: by high Chimgan and Qzil-Nura-Tay in the south-east, by Pskem and Qzil-Sui mountains in the north-west, and by Karjantau offshoots in the west. Its south-west is not blocked by the mountains. Physiographic characteristics of the area of Chirchik boiler-houses are conditioned by a severely continental climate with high amplitudes of day and seasonal temperatures, low precipitation and their uneven distribution among seasons, long, hot and dry summers and short dry winters.

In this area, the north-east wind blowing from the mountains and amounting to 50% of all other wind directions prevails all over the year. In winter, frequency of this wind is the highest (61-65%) it becomes less frequent in spring and goes down to its minimum values (41-42%) in summertime. The north-easter becomes more frequent again in autumn. Average northeaster's speed is 4.5 m/sec. Frequency of calm weather varies from 10 to 28% during a year. Wind pattern in the Chirchik area is characterized by well-defined mountain-and-valley circulation in the warm half of a year, especially in summer.

The lowest temperature is registered in January and its monthly average value is 0.9ºC. Its intensive increase starts in March-April, and the highest temperature is registered in July when monthly average temperature is 26.7ºC. In August, temperature slowly goes down. Autumn is warmer than spring. Average temperature in December and February are above zero. "Real" winter with temperature below zero in Chirchik averages 30 days.
Chirchik compared to other towns of Tashkent province and the city of Tashkent is characterized by less frequent gentle winds, ground inversions, and air blanketing – climate characteristics contributing to hazardous substance accumulation in the air.

Thus, the area for projected construction is highly favorable in terms of climate characteristics determining air dispersion of hazardous substances. However, insufficient precipitation in summertime complicates self-purification of the air and other environment components from natural and man-made dust.

Air quality and existing pollution sources. There are more than 50 enterprises polluting air in Chirchik among which most important are: "MAXAM-CHIRCHIQ" OJSC, "Transformator" OJSC, "Uzbekhimmash" OJSC, "Chirchiqselmash", and "Chirchiqgas". Construction enterprises and in particular construction material producer, experimental coating plant, and Uzbek industrial complex for producing refractory and high-temperature-resistant materials (UzKTJM OJSC) are also important sources of air pollution. In addition to these enterprises, vehicle exhausts also pollute the air. Vehicle parks are located at 63 automobile services and enterprises. City air is mostly polluted with exhausts from vehicles moving along A. Timur, Kangli, Usupov, Ramazan, and A. Navoi streets.

According to 2013 data, pollutant emissions of "MAXAM-CHIRCHIQ" make the highest share (60,2%) in the total pollutant emissions. Analysis of statistical data has shown that there was a 1.05-time reduction in dust emission and 1.38-time reduction in nitrogen oxide emission compared to 2012; also there is a trend of reduced emissions of sulfur dioxide and hydrocarbons. But there was an insignificant 1.05-time increase of carbon oxide emissions compared to 2012.

14 boiler-houses of Chirchik "Issiklik Energiyasi" district heating company also significantly contribute to air pollution are located near residential areas. Among them "Ubileynaya" BH-1, "OKBA" BH-2, "Rudaki" BH-4, and "Microdistrict 8" BH-14 are the largest sources of nitrogen and carbon oxide emissions. Gross emissions of Chirchik "Issiklik Energiyasi" are presented in *table 12*.

Table 12. Air Pollutant Emissions of Chirchik "Issiklik Energiyasi"

Hazardous substances	*Air emissions (tons per year)*	
	Estimated	*Actual*
Carbon oxide	331.453	177.6872
Nitrogen dioxide	126.670	61.687
Nitrogen oxide	20.5484	15.419

Table 12 above shows that actual air pollutant emissions are lower than projected figures. Lower pollutant emissions in the last years are related to less working hours of the plant to meet seasonal needs in heating and hot water. The share of Chirchik "Issiklik Energiyasi" company in the total city air pollution is 7, 48%.

Air quality is caused by combination of two factors: pollutant emissions and conditions of their dispersion. Chirchik in terms of climate conditions affecting air dispersion of hazardous substances is one of the most favorable areas with a moderate air pollution potential of 2,7. *Table 13* presents observational data on the city air pollution by the RUz Glavgydromet (Hydrometeorological Centre).

Table 13. Annual Average Concentrations of Air Pollutants in Chirchik (as a share of maximum permissible level)

Substance	*2011*	*2012*	*2013*

Dust	0.5	0.5	0.5
Ammonia	0.33	0.42	0.5
Nitrogen dioxide	0.5	0.5	0.33
Nitrogen oxide	0.08	0.16	-
Sulfur dioxide	0.035	0.04	0.03
Carbon oxide	0.25	0.25	0.25

Table 13 shows that annual average levels of pollutants for the last three years did not exceed maximum permissible levels (MPL for all substance). In 2013, air pollution with ammonia increased from 0.33 to 0.5 MPL compared to 2012, but at the same time air pollution with nitrogen dioxide decreased from 0.5 to 0.33 MPL. Air pollution level of other components remained unchanged.

Toxicological-hygienic assessment has shown that current air pollution is moderate with health damage level. Pollutant dispersion analysis was made to assess impact of Chirchik "Issiklik Energiyasi" boiler-houses on air pollution. For this purpose, the "ECOLOG" software was used to calculate pollutant concentrations on the area 12 km*13 km with a step of 500 m. Parameters of pollution sources were determined on the basis of equipment technical and economic indicators and summarized in *table 14*.

Table 14. Characteristics of air pollutants (currently)

#	*Substance*	*MPL or SRLI, mg/m^3*	*Hazard rating*	*Established quota (share in MPL)*	*Maximum concentration outside the industrial area (share*	*Conformity with the established*	*Total emissions (tons/year)*	*Share in emissions (%)*
1	Nitrogen dioxide	0.085	2	0.20	0.28	-	126.670	26.46
2	Nitrogen oxide	0.6	3	0.25	Total max <0.1*	+	20.5484	4.300
3	Carbon oxide	5.0	4	0.33	Total max <0.1*	+	331.4532	69.24

According to the calculations of air pollutant dispersion due to boiler-houses operations, maximum concentrations of nitrogen dioxide in the city exceed the established quota 1.4 times.

Geological structure. Chirchik is located in a submountain alluvial-proluvial valley of the Chirchik River – mostly on terraces above the flood-plain within low offshoots of mountain ranges and foothills. Geological setting of Chirchik determining its geotechnical conditions include Middle Quaternary 50-m thick loess-like deposits, Upper Quaternary deposits and recent beds. The top of quaternary deposits is composed of loess-like and loamy soils. As to geomorphology, Chirchik is located on the third terrace of the Tashkent area and is composed of alluvial loess soil of the Syrdarya complex. The floodplain is composed of sand and gravel which thickness is 19-24 m. Filled layer composed of loamy soil is located right on the top of these deposits.

Soils. Soil in the area of the city boiler-houses belong to typical grey soils with evident signs of gritty consistency due to the presence in soil of coarse fragments and pebbles of mountainous massive rocks. Man-made factors have a significant impact on topsoil caused by intensive pollutant emissions by Chirchik enterprises. Soil quality in the area of Chirchik "Issiklik Energiyasi" boiler-houses "should be recognized satisfactory".

Groundwater. Locations of the city boiler-houses are characterized by significant territorial variations of groundwater level. Depending on land terrain and ground levels, groundwater level may range within significant limits. Groundwater in the area of boiler-houses is revealed 5-10 m from the surface. Soils are assessed as non-aggressive to concrete.

Vegetation. Air pollution analysis in Chirchik has shown that current concentrations of dust, nitrogen oxides, sulfur dioxides and carbon oxide are not toxic for vegetation, and, therefore, there is no significant negative effect on flora. According to the research of vegetation composition, the area of Chirchik "Issiklik Energiyasi" has such trees as thuja, ash-leaved maple (*Acer negundo*), eastern plane, and fruit-bearing plants: apple trees, cherry trees, peach trees, nut trees, and grapes. Visual inspection of plants revealed insignificant dustiness of leaves.

Social and economic aspects. Chirchik is a large industrial center of Uzbekistan with well-developed industries: chemical, machinery and equipment, electrical engineering, metallurgy, energy, transport, and construction. Population of Chirchik is 153.5 thousand people who mainly reside in four-storey apartment buildings with all basic amenities, although there are a lot of private houses. 57,606 residents are connected to district heating, and the rest live in private houses and have individual heating equipment. Residential and public buildings are connected to water supply, power supply and telephone systems. Industrial enterprises "MAXAM-CHIRCHIQ" OJSC, UzKTJM OJSC, "Transformator", "Uzbekhimmash", and "Chirchiqselmash" employ the most part of the working-age population (62,900 people).

3.2.3. Analysis of project alternatives

Technological options. The main goal of construction, reconstruction, and modernization of the Chirchik district heating is to organize such a system that would ensure full and high-quality uninterrupted heating of all consumers and minimize energy generation and transportation losses.

The following options have been considered in developing a heating system modernization project in Chirchik:

- To reconstruct and modernize existing heating facilities and networks;
- To construct new boiler-houses in the areas that were heated by industrial boiler-houses;
- To construct individual heating substations with the use of new energy-efficient equipment.

In the result of conducted technical and economical analysis was decided to construct 4 local boiler-houses for 144 residential buildings, local boiler-houses for 26 residential houses, autonomous boiler-houses for 33 residential houses, and 5 local BHs for social institutions. Construction of solar collectors for hot water supply in summertime was also recommended under the project - 4 boiler-houses with vacant spaces for solar collectors have been selected under the project. In the result of project implementation, the capacity of Chirchik "Issiklik Energiyasi" boilers will be 304.354 Gcal/hr, of which 26.0 Gcal due to the construction of 4 local boiler-houses and 23.954 Gcal/hr due to the construction of local and autonomous boiler-houses for social institutions. They will work in a non-stop mode with 8,760 working hours.

Location options. Chirchik "Issiklik Energiyasi" will be reconstructed and modernized without expansion of the existing sites. Local boiler-houses with installation of upgraded boilers will be constructed all over Chirchik. Power, natural gas, and water will be supplied directly from existing municipal networks. Other location alternatives have not been considered.

Zero option. In case of abandoning reconstruction and modernization of Chirchik heating system it will deprive the population in Chirchik of the opportunity to receive heating and thus zero option has been rejected.

3.2.4. Impact Assessment

Air pollution. To determining air pollution impact of Chirchik "Issiklik Energiyasi" boiler-houses, the "ECOLOG" software was used to calculate pollutant concentrations in the area 12 km*13 km with a step of 500 m (see *table 15*).

Table 15. Current characteristics of air pollutants

#	Substance	MPL or SRLI (mg/m^3)	Hazard rating	Established quota (share in MPL)	Maximum concentration in the city area (MPL share)	Conformity with the established quota (+/-)	Total emissions (tons/year)	Share in total emissions, %
1	Nitrogen dioxide	0.085	2	0.20	0.15	+	85.5238	25.39
2	Nitrogen oxide	0.6	3	0.25	Total max <0.1*	+	13.6602	4.056
3	Carbon oxide	5.0	4	0.33	0.01	+	237.553	70.554

Overall operation of boiler-houses will entail emissions of 3 pollutants – carbon monoxide, nitrogen dioxide and oxide. With the projected rate operation, gross pollutant emissions will amount to 336.737 tons/year, of which 37.582 tons/year from local and autonomous boiler-houses and social institutions. "Ubileynaya" BH-1, "OKBA" BH-2, "Uzbekhimmash" BH-11, "Microdistrict 8" BH-14, and "Maxam Chirchik" BH-16 are the main sources of air pollution. But maximum concentrations of all emissions do not exceed the established quotas, and air impact is projected as admissible.

Table 16 below presents BH impact intensity on ambient air at the present time and under the project. Given the construction of 4 new BHs and local BHs for residential buildings and social institutions the total emissions will be 336.737 t/year and would decrease for nitrogen dioxide by 41.147 t/year (32.48%), for nitrogen oxide – by 6.888 tons/year (33.52%), and for carbon monoxide – by 93.90 tons/year (28.32%). Current air pollutant impact after reconstruction, modernization, and construction of new boiler-houses are presented in *table 17*. The table shows that nitrogen dioxide impact will be reduced by 0.13 MPL, carbon monoxide – by 0.07 MPL and nitrogen oxide level will decrease significantly. As the level and area of air pollutant impacts are insignificant, reconstruction and modernization of Chirchik "Issiklik Energiyasi" boiler-houses will have a little impact on human health, soil, and vegetation.

Table 16. BH impact on ambient air currently and under the project

Boiler-houses	*Currently (tons/year)*				*Under the project (tons/year)*			
	Carbon monoxide	*Nitrogen dioxide*	*Nitrogen oxide*	*Total*	*Carbon monoxide*	*Nitrogen dioxide*	*Nitrogen oxide*	*Total*
1	2	3	4	5	6	7	8	9
Ubileynaya BH-1	119.392	46.815	7.600	173.807	40.793	15.733	2.550	59.076
OKBA BH-2	42.634	16.428	2.670	61.732	38.026	14.064	2.285	54.375
Children's hospital BH-3	7.3512	2.413	0.392	10.1562	5.006	1.644	0.267	6.9170
Maternity House BH-4	6.600	2.256	0.341	9.197	2.700	0.880	0.142	3.722
Ak-kavak BH-5	6.816	2.398	0.3896	9.6036	4.1909	1.415	0.230	5.8359
Municipal hospital BH-6	Closedown							
School 18 BH-7	0.558	0.159	0.0257	0.7427	0.1440	0.0410	0.0066	0.1916
School 10 BH-8	0.519	0.148	0.024	0.691	0.1440	0.0410	0.0066	0.1916
School 22 BH-9	0.420	0.108	0.0176	0.5456	0.1440	0.0410	0.0066	0.1916
Nijniy Komsomol. BH-10	17.250	6.300	1.023	24.573	8.386	3.063	0.3982	11.8472
Uzbekhimmash BH-11	19.380	7.142	1.1605	27.6825	13.061	4.8180	0.782	18.661
ChTZ BH-12	4.215	1.539	0.250	6.004	1.6720	0.6110	0.093	2.3760
Rudaki BH-13	28.818	11.100	1.804	41.722	18.207	7.022	1.141	26.370
Microdistrict 8 BH-14	77.50	29.864	4.851	112.215	42.067	16.223	2.636	60.926
UzKTJM BH-15-1					6.720	2.299	0.3230	9.3420
UzKTJM BH-15-2					9.290	3.178	0.5163	12.9843
UzKTJM BH-15-3					6.300	2.155	0.2800	8.735
Maxam Chirchik BH-16					12.418	4.289	0.697	17.404
Visokovoltnaya St.					0.137	0.030	0.0048	0.1718
Khojaev St.					0.4450	0.1190	0.0154	0.5794
Shimoliy St.					0.3930	0.1050	0.0171	0.5151
Mukimi St.					0.4190	0.0300	0.0039	0.4529
Sharq St.					1.848	0.5580	0.0906	2.4966
Navoi St.					0.373	0.0900	0.0145	0.4775
Timur St.					1.170	0.534	0.0867	1.7907
Sadaf St.					0.2420	0.0732	0.0119	0.3271
Microdistrict 4 St.					0.3670	0.1200	0.0156	0.5026
Shalandin St.					0.478	0.1569	0.0255	0.6604
Microdistrict 10					1.5930	0.4800	0.078	2.1510
Autonomous boiler-houses for 33 residential								

buildings								
Sharq St.					2.1630	0.580	0.0942	2.8372
Mukimi St.					3.429	0.919	0.1493	4.4973
Pobeda St.					7.6180	2.0440	0.3321	9.9941
Usupov St.					2.6550	0.7120	0.1157	3.4827
Nasir St.					1.554	0.4160	0.0670	2.0370
Uritskiy St.					1.730	0.603	0.0980	2.431
Social entities								
Preschool 7					0.170	0.0371	0.006	0.2131
Preschool 22					0.334	0.0897	0.0145	0.4382
School 26					0.5376	0.1442	0.0234	0.7052
School 17					0.5830	0.1565	0.0253	0.7648
Police					0.0458	0.0092	0.0014	0.0564
Subtotal					28.2844	8.0068	1.2909	37.5821
Total	*331.4532*	*126.670*	*20.5484*	*478.6716*	*237.553*	*85.5238*	*13.6602*	*336.737*

Table 17. BHs impact on air quality currently and under the project

Pollutant	*Currently*		*Under the project*		
	Estimated maximum concentration in the city area (share of MPL)	*Sources with highest share in maximum concentration (%)*	*Estimated maximum concentration in the city area (share of MPL)*	*Sources with highest share in maximum concentration (%)*	*Quota, share of MPL*
1	2	3	4	5	6
Nitrogen dioxide	0.28	Source 1 Ubileynaya BH-1 -41.6% Source 2 Ubileynaya BH-1-58.4%	0.15	Maxam Chirchik BH-16 - 99.19%	0.2
Nitrogen oxide	0.04	All boiler-houses	<0.1	All boiler-houses	0.25
Carbon monoxide	0.08	All boiler-houses	0.01	All boiler-houses	0.33

Air will be also polluted with other substances (nonorganic dust, ferrous oxides, silicon and manganese compounds, and welding aerosol) mostly during civil works for replacing the old pipelines and construction of IHSs, although their environmental impact is considered as temporary and local.

Chemical substance emission and discharge into soil and vegetation. Air pollutants from boiler-house operations will not negatively affect soil and vegetation as their ground level concentrations are less than 0.0 MPL.

Water pollution and use. Start-up operations of boiler-houses after reconstruction works will not impact the surface water as they use water from the municipal water-supply system. There is no discharge of pollutants into the surface water. Wastewater from boiler-houses (155.4 m^3/day or 56,736.365 m^3/year), of which technological wastewater – 134.53 m^3/day (49,101.0 m^3/year) and domestic wastewater – 20.91 m^3/day (7,632.365 m^3/year), flows into a municipal sewerage system.

Boiler-house operation requires also technical water for technological and domestic needs. Water consumption for technological needs amounts to 3,836.75 m^3/day (1,400.417 thousand m^3/year). Water consumption for domestic needs is 20.91 m^3/day, for area sprinkling – 14.029 m^3/day, for irrigation of trees and plants – 8.98 m^3/day. Total water consumption will amount to 3,880.68 m^3/day (1,416.449 thousand m^3/year). Water will be withdrawn from the municipal water supply network. Water consumption prior and after reconstruction is presented in *Table 18*, and according to the data water consumption will be reduced due to lower consumption for maintaining water chemical treatment plants. Under the project, all water treatment plants will be stopped except for "Rudaki" BH-13 and "Microdistrict 8" BH-14. Water will be treated with the use of mineral salt inhibitor (MSI).

Table 18. Water consumption in city's district heating system

Types of water consumed	*Currently*		*Under the project*	
	m^3/hr	*m^3/day*	*m^3/hr*	*m^3/day*
Water for technical needs, single water filling of heating networks, adding of water, washing of containers	229.211	5,501.069	159.864	3,836.75
Domestic needs	1.826	43.824	1.85	43.923

Impact on soil and land resources. In terms of long-term impact of all pollutants discharged by boiler-houses, their concentration in soil is not expected to exceed the established MPL. Soil impact would include its mechanical damage due to excavation and leveling works during replacement of pipes and foundation construction of mini boilers. Soil and groundwater impact can be also due to spillages of oil products used as fuel for motor vehicles and construction equipment. While only existing buildings of the boiler-house will be reconstructed and modernized, allocation of new land resources will not be required. 0.088 ha of land resources will be taken for the construction of 4 boiler-houses, local and autonomous boiler-houses for 26 and 33 residential buildings, and 5 social institutions.

Waste generation. The waste generated under the project includes metal pipes (1,802.0 thousand tons), non-asbestos mineral wool (0.0279 thousand tons), asphalted felt (0.0860 thousand tons), replaced boilers, and lining materials. According to waste classification by

hazard categories, asphalted felt and mineral wool are included in Hazard Class 2. Waste metal pipes are transported to 'Vtorchermet' for recycling, dismantled boilers are transported to 'Vtorchermet', lining material, asphalted felt and mineral wool are also subject to recycling.

Impact on vegetation. Species composition and plant productivity may be impacted by natural and man-made factors although maximum ground-level concentrations of pollutants are significantly lower than those resulting in vegetation damage. Moreover, nitrates discharged in soil are a biogenic element and they are engaged in vegetation protein metabolism contributing to their growth. Additional planting of industrial sites under the project will improve microclimate in the territory of Chirchik "Issiklik Energiyasi" boiler-houses. Therefore, there will be no negative effect on the vegetation.

Construction traffic. The transportation activities and traffic could lead to traffic congestion and inconvenience to the public due to: (i) increased vehicles for materials and solid wastes transportation, and (ii) deterioration of the roads condition after asphalt milling and excavation and leveling. It might bring negative effects to the narrower road and cause larger vehicle flux.

Noise and vibration. The following construction works will produce noise: (a) Foundation construction and concrete mixing; (b) Assembling of steel construction units and installation of equipment; (c) Site cleaning and putting boiler-houses into operation. Noise will not exceed permissible norms, provided that properly functioning equipment is used. It is also expected noise in the area of nearby residential buildings will not exceed the admissible level according to construction norms and regulations 2.01.08-96.

Health and safety impact. Personnel health will not be impacted provided that occupational safety and health rules are introduced and followed. Reconstruction and modernization of boiler-houses will enable to meet the people's needs in heat and hot water. Operation of Chirchik "Issiklik Energiyasi" boiler-houses in compliance with technical and occupational safety rules will have no significant environmental impact and have positive impact on human social situation.

3.2.5. Environmental Mitigation Plan

The proposed mitigation measures are to large extent similar to those described already above in the point 3.1.5. *Table 19* presents the mitigation plan for afjusted to the situation of the Chirchick project.

Table 19. Mitigation plan

Process resulting in environmental impact	*Environmental impact features*	*Environmental impact duration Local/continuous*	*Measures to reduce environmental impact*	*Institutional responsibility*
1	2	3	4	5
Impact during reconstruction of the city heat and hot water supply system				
1. Replacement and reconstruction of pumping equipment	Waste accumulated during dismantling of equipment and construction units; air pollution during demolition and removal of equipment and construction units, and welding works during dismantling phase; noise as a result of working equipment; labor safety	Local – phase of construction works	Separation of all wastes accumulated during dismantling of equipment and construction units and their shipment to city landfill or to enterprises collecting ferrous wastes; strict control over the use of motor vehicles and construction equipment in accordance with established standards; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	Management of the contractor
2. Replacement of boiler and supporting equipment	Waste accumulated during dismantling of replaced equipment and construction units; air pollution during delivery and transportation of construction materials to the sites, welding works, concrete preparation works, and excavation works; noise as a result of working equipment; personal safety issues	Local – phase of construction works	Distribution of all wastes accumulated during dismantling of equipment and construction units among enterprises specialized in their disposal and storage; strict control over the use of motor vehicles and construction equipment in accordance with established standards; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	Management of the contractor
3. Construction of new local BHs	Possible tree cutting down in the construction sites; soil damage during construction site leveling; air pollution during preliminary site works and construction of local BHs; noise as a result of working equipment; labor safety	Local – phase of construction works	Selection of sites requiring minimum greenery cutting down for local BHs construction; soil removed during leveling works should be preserved during construction phase and used for planting of greenery on the site upon completion of construction works; strict control over the use of motor vehicles and construction equipment in accordance with established standards; respecting labor safety rules; personnel training on occupational safety and measures towards	Management of the contractor

			compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	
4. Reconstruction of main and distribution heat pipe networks	Emissions during dismantling of old heat networks (welding equipment, motor vehicles); new heat supply networks require trench works and installation of concrete beds – air pollution with fuel combustion products from equipment, dust emission; soil damage; possible cutting down of trees; emissions due to welding works during installation of pipelines; labor safety	Local – phase of construction works	Distribution of all wastes accumulated during dismantling of heat networks among enterprises specialized in their disposal and storage; strict control over the use of motor vehicles and construction equipment in accordance with established standards (during dismantling and construction works); selection of the optimal route for heat networks; involvement of highly qualified specialists to minimize consumption of welding materials; preserving of soil removed during pipeline construction for its further use for leveling.	Management of the contractor
5. Installation of Individual Heating Stations	Emissions during civil works; construction waste generation; noise; air pollution with dust; labor safety.	Local – phase of civil works	Proper construction waste management; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc. .	Management of the contractor
6. Solar plant construction	Emissions during welding operations; construction waste; noise	Local – phase of civil works	Proper construction waste management; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	Management of the contractor

Impact during operation				
Heat and hot water supply to consumers	Air pollution due to operation of BHs; water consumption and contaminated water discharge; industrial wastes due to maintenance and overhaul of boiling equipment	Continuously – during operation	To reduce air pollution, the project provides for the use of new energy and cost efficient gas-fueled condensation boilers; water consumption and discharge will be reduced through the introduction of a closed heat supply system and construction of individual heating substations in residential and public buildings; distribution of all wastes accumulated during maintenance works among enterprises specialized in their disposal and storage; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	District heating company

3.2.6. Monitoring and supervision plan

In order to ensure efficient implementation of the mitigation measures proposed, including compliance with environmental requirements during the construction stage, a program of monitoring activities will be required (see it below in *table 20*). Inspections of construction sites are among the duties of the district heating authorities' staff and are covered form their budgets. The impact monitoring on water and air quality, noise, etc., will be done by Contractors and periodically by district heating company. Costs for monitoring activities during the Project construction phase should be included in the bill of quantity for proposed civil works.

Table 20. Monitoring of EMP implementation

Project activity /Mitigation Measure	*Where (is the parameter to be monitored?)*	*What (is the parameter to be monitored?)*	*How (is the parameter to be monitored?)*	*Who (is responsible for monitoring?)*	*When (define the frequency / or continuous?)*	*Cost/sources of financing*
1	2	3	4	5	6	7
1. Reconstruction of existing boiler – houses (DBHs) / prevention of air pollution; waste management (collection, separation and disposal); ensuring labor safety through training and provided protective closes	Boiler-houses	Emissions/ dust, NOx; SO2; CO	Visual monitoring; Instrumental observations at the site	Contractor; DH company; State Committee for Environmental Protection	Daily for dust; Measurement of pollutants - before commissioning	Contract-based; Budgetary resources
		Waste/Waste weight and type and related expenditures	Data on collected, separated, transported and disposed along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract-based;
		Occupational safety/conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Constructor; District heating company	Monthly and based on the needs	Contract-based; District heating company operational resources
2. Dismantling of local boiler – houses (BHs) prevention of air pollution; waste management (collection, separation and disposal); ensuring labor safety through training and provided protective closes	Equipment room	Emissions/ dust	Visual monitoring;	Contractor; DH company;	Daily	Contract-based; Budgetary resources
		Waste weight and type and related expenditures	Contractor data on collected, separated, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract-based;
		Occupational safety/number of accidents; conducted specialized training, number of participants	Accident register; Training register; Expenditures for	Constructor; District heating company	Monthly and based on the needs	Contract-based; District heating company operational

		and provided protective closes	protective closes			resources
3. Replacement or exhausted pipelines of heat supply pipelines/ Soil protection; Prevention of air emissions from vehicles and equipment and watering for dust prevention; Noise prevention through calibration of equipment and working during daily time hours; Construction waste management – their collection, separation and disposal; Potential tree loses; Ensuring labor safety.	Pipeline route	Emissions/smoke from vehicles and working equipment; Dust; Expenditures.	Visual monitoring; Expenditures for watering	Contractor	Daily	Contract-based
		Soil protection/ volume of excavated and/or recultivated soil (m3)	Data on implemented works and on related expenditures	Contractor	Weekly	Contract-based
		Waste/type and weight; associated expenditures	Contractor data on collected, separated, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract-based
		Noise/level of noise in DbA	Instrumental measurements	Contractor; Sanitary inspection	Weekly	Contract based; District heating company resources
		Number of trees cut	Expenditures for tree cut	Contractor; District heating company	Monthly	District heating company resources
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources
4. Construction of new local and mini boiler-houses/ Soil protection; Prevention of dust and emissions from equipment; Noise prevention; Construction waste management; Potential tree loses	Project site	Emissions/dust and equipment emissions	Visual monitoring	Contractor	Once	Contract-based
		Waste/weight	Contractor data on collected, transported and disposed waste along with the data on expenditures for implemented waste management activities			
		Noise/level of noise in DbA	Instrumental measurements	Contractor; Sanitary inspection	Weekly	Contract based; District heating

Ensuring labor safety						company resources
		Number of trees cut	Expenditures for tree cut	Contractor; District heating company	Monthly	District heating company resources
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources
5. Solar plant construction / equipment emissions; Construction waste; noise	Construction site	Emissions / dust and welding pollutants	Visually	Contractor	Daily	Contract based
		Noise / DbA	Observations	Contractor; Sanitary inspection	Weekly	Contract - based
		Waste / type and weight, expenditures	Contractor data on collected, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract - based
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources
		Noise / DbA	Observations	Contractor; Sanitary inspection	Weekly	Contract - based
		Waste / type and weight, expenditures	Contractor data on collected, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract - based
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources
6. IHS construction /	Residential	Emissions/dust and equipment	Visual monitoring	Contractor	Once	Contract-based

Prevention of dust and emissions from equipment; Noise prevention; Construction waste management; Ensuring labor safety	buildings	emissions				
		Noise/level of noise in DbA	Instrumental measurements	Contractor; Sanitary inspection	Weekly	Contract based; District heating company resources
		Waste/weight	Contractor data on collected, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract based; District heating company resources
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources

3.2.7. State Ecological Expertise approval.

The EIA&EMP study for Chirchik city has been submitted for its review and approval to the State Committee for Environmental Protection (State Ecological Expertise) and on October 24, 2014 it has been officially approved (Decision No. 18/1202). The SEE decision specifies overall the EA report is of good quality and corresponds to all national environmental requirements. The document also mentions the next EA step should be presenting to the SEE before putting in operation the district heating the Declaration on environmental impacts along with all necessary environmental permits and licences (in particular for air emissions, for waste water discharges, waste management). It is also indicated the Tashkent Committee for Environmental protection will keep under control and supervise the waste management during dismantleing of BH equipment.

3.3. EIA & EMP for Tashkent Sergili district

3.3.1. Current status of city's district heating system and proposed investments.

To generate heat for heating and hot water supply, the Heating Plant 8 (HP-8) which serves the Sergili city district is equipped with hot-water boilers – two peak-load water-heating boilers fueled by mazut (MPLWH-50) with capacity of 50 Gcal/hr and two gas-and-mazut water-heating boilers (GMWH-100) with capacity of 100 Gcal/hr. The boiler-house is also equipped with steam boilers – upgraded double-cylinder vertical water-tube boilers (UDCWT 6.5-13) – for heating-up mazut (as the reserved fuel) in wintertime. The current capacity of Sergeli HP-8 boilers is 300.0 Gcal/hr and over. It works in a non-stop mode with 8,400 working hours.

The number of facilities connected to heating networks of Sergeli HP-8 in Sergeli district is 1,010, of which 830 multi-storey apartment building, 123 state-financed organizations, and 57 commercial enterprises. Both main and submain heating lines are constructed above ground on high supports and underground in reinforced concrete ducts. Currently, the length of heating networks is 88.365 km, of which above ground – 54.267 km and underground – 34.097 km. Due to physical deterioration and obsolescence of heating mains and in-house networks and above-limit system operations, heat and hot water consumption is higher than normative standards for heating-system water and power consumption. The efficiency of Sergeli HP-8 operation is very low; there were no repair works and extensive repair of exhausted main and distribution heating lines neither were there works to introduce energy efficient technologies or replace old equipment with the new one. In addition, depreciated in-house technical equipment and heating systems in multi-storey apartment buildings do not allow providing residential heating according to effective specified parameters. Pipelines in basements and under the roof space of multi-storey apartment buildings are operated without thermo-insulation.
Natural gas is the main fuel while mazut serves as a standby fuel. Currently, Sergeli HP-8 distributes hot water through an open system, i.e. water is taken directly from a heat-supply network. Based on 2013 heat source data, heat-transfer fluid's temperature in a supply pipeline did not exceed 75^0C. Low temperature of heating water was caused by the use of corrosion inhibitor – mineral salt inhibitor (MSI). As to chemical characteristics, the inhibitor requires low temperature of the heating fluid. This scheme has the following deficiencies:

- high heat consumption for heating and hot water supply;
- high fuel and power consumption per unit;
- higher costs of operation of boiler-houses and heat networks;
- inadequate quality of consumers heating due to high heat losses and large number of damaged heat networks;
- higher costs of water chemical treatment.

To ensure adequate and uninterrupted heating of enterprises and residential areas in this district, as well as to improve environment in the Sergeli HP-8 impact zone, it is necessary to create a modern resource-efficient system of high-quality and uninterrupted heating to address the needs of population and social facilities in heating and hot water, install new energy-saving boiler and supporting equipment, introduce modern schemes of energy consumption, equip consumers with energy meters, use renewable energy sources, and ensure complete automation of heating generation and transportation.

The project provides for the following works to modernize and reconstruct HP-8 due to the introduction of a closed heat supply system:

- Boilers modernization;
- Replacement of exhausted heat supply pipes;
- Replacement of water supply networks;
- Construction of individual heating substations (IHS) in residential buildings;
- Construction of transformer substations and power supply networks;
- Installation of a solar plant at the site.
- Introduction of a closed system will enable to ensure:
- lower heat consumption for heating and hot water supply due to the introduction of quality and quantity control of heat fluid's temperature in accordance with a temperature chart;
- lower corrosion and salinization of pipelines;
- lower depreciation rate of boiler-house's equipment;
- massive improvement of heating supply quality for consumers, prevention of excessive heating when it is warm outside during a heating season;
- less work for chemical treatment of heat water and lower corresponding costs;
- lower accident rate of heating systems.

Upgrading of large water-heating boilers is based on achievements in production design and engineering from large-scale energy projects that ensure introduction of new technical solutions. To upgrade large water heating boilers (MPLWH and GMWH), technical solutions provided by 'Dorogobujkotlomash' OJSC based on Technical and Commercial Proposal #22/08-7 (dated August 22, 2014) were adopted. Upgrading of a GMWH-116, 3-150 boiler (GMWH-100-150) and a GMWH -58, 2-150 (MPLWH-50) boiler requires the following modifications in boiler's design:

- Reconstruction of a boiler's frontal part with the use of interconnections for burner arches;
- Replacement of existing burners with new generation gas-and-mazut re-circulating burners (GMRB-35) with a lower level of hazardous emissions, - these burners were developed on the basis of advanced technologies ensuring higher fail-safety, cost effectiveness and compliance with environmental standards. Each burner has an oil lighter (2 pieces – one of them for a backup), fixed igniter, air flow control, flame and ignition control equipment to ensure selective control over the main burner's flame for all operation modes of a boiler, including ignition mode. Burners demonstrate operational stability within the load range from 25 to 100%;
- Elimination of a common air duct and installation of a flexible insert before each burner; replacement of air ducts before ventilator, if needed;
- Installation of a new upgraded intermediate shield and replacement of crossover piping;
- Replacement of the higher segment of a convection section (4-way instead of 2-way);
- Reconstruction of side-shields and changing location of inspection holes;
- Gas project with installation of gas fuel units (GFU-9) (4 items);
- Automated process control system project;
- Introduction of electric pumps with frequency regulation.

In addition, existing main and submain heating networks will be relayed, and pipes will be insulated with the use of polyurethane foam which will save heat and natural gas consumption and lower pollutant emissions. Individual heating substations will be constructed in the area

of boiler-house operation. Individual heating substation is a complex of plants to distribute heat supplied by heat network among consumers in accordance with the established type and parameters of a heat-transfer agent. Sites for solar plants will be located in compliance with the following requirements: fire safety, town-planning, electrical safety, manufacturers' technical requirements including technical, technological, climate, and geographic characteristics of an enterprise. Due to the lack of vacant spaces to install the estimated amount of solar collectors and high costs of their maintenance, the project has accepted a block of 42 solar collectors with an hour load of 0.012 Gcal/hr (hot water supply). The remaining required load is replenished from a heating source.

- Established total number of solar collectors for 27 facilities - 1,134
- Total space for solar plants - 2970 m^2
- Total heat generation in summer – 1,161 Gcal/year
- Gas saving in summertime – 187.92 thousand m^3/year.

As the heating system is closed, the heat substation will have water-to-water heaters, in most cases two-stage ones, which will allow reducing water consumption in the heating system. Upgrading and modernization of boiling equipment will fully comply with standards of environmental safety and efficient fuel consumption.

3.3.2. Baseline analysis

Description of area physiographic location and climate conditions. The HP-8 is located in the northeast of Sergeli district of Tashkent at the intersection of Sugdiena and Loyiha streets. Private housing area is located 100 m to the east of the HP-8, industrial zone surrounds the boiler-house in the west and north, and an enterprise manufacturing sunshields is located 250 m to the south of the boiler-house. The City of Tashkent is a large industrial center of Uzbekistan with well-developed industries: chemical, machinery and equipment, electrical engineering, energy, transport, and construction. Physiogeographic characteristics of Tashkent determine its climate conditions, especially wind patterns. Wind patterns in Tashkent and its surroundings are characterized by east, northeast winds in wintertime and north, northwest winds in summertime. Annual average wind speed is 1.9 m/sec.

The lowest temperature is reported in January (monthly average – minus 1.6˚C), the hottest month is July (monthly average +35.7^{o}C). Annual average precipitation is 441.7 mm. Minimum precipitation is reported in summertime. Thunderstorms are reportedly most frequent in summertime.

Air quality. Due to climate characteristics as recurrence of gentle winds, ground inversions, air stagnation that contribute to the accumulation of air pollutants, Tashkent city has a higher air pollution potential than other towns of the Tashkent oblast. Overall the area of Tashkent belongs to the zone with a high air pollution potential (APP) of 3.2. Statistical data analysis shows that in 2013 there was a 1.04-time reduction in dust emissions and a 1.2-time reduction in nitrogen oxides if compared to 2012, as well as there is a trend of reduced emissions of sulfur dioxide, carbon oxide, and nitrogen dioxide. The share of Sergeli HP-8 in the city air pollution is 2.75 %. Pollution sources of Sergeli HP-8 are presented below in the *table 21*.

Table 21. Gross emissions of Sergeli HP-8

Hazardous	*Emissions, tons per year*

substances	*Projected*	*Actual*
Carbon oxide	1517.86	459.65
Nitrogen dioxide	560.26	169.52
Nitrogen oxide	91.042	27.56
Total	2169.162	656.73

Lower pollutant emissions in the last years are related to less working hours of the plant to meet seasonal needs in heating and hot water. The share of Sergeli HP-8 in the total city air pollution is 2.75 %.

Table 22 below presents observational data by the RUz Glavgydromet (Hydrometeorological Centre) in terms of the city air pollution level.

Table 22. Annual average concentrations of air pollutants in Tashkent (as a share of maximum permissible level)

Substance	*2011*	*2012*	*2013*
Dust	0.7	0.7	0.7
Sulfur dioxide	0.0	0.1	0.1
Carbon monoxide	0.7	0.7	0.7
Nitrogen dioxide	1.3	1.3	1.0
Nitrogen oxide	0.7	0.3	0.5
Phenol	0.3	0.7	0.7

Table shows that annual average levels of pollutants for the last three years did not exceed maximum permissible levels (for each substance). In 2013, air pollution level remained unchanged compared with 2012. Toxicological-hygienic assessment has shown that current air pollution level is moderate.

Geological and hydrogeological conditions. As to geological setting, the area of HP-8 has recent beds of the Syrdarya complex presented in the form of up to 2-meter loess-like sand clays and loams, lower by gravelites, pebble stones and sand. They are underlain by Middle Quaternary loess-like and arenaceous deposits, and the lower part – with pebble stones and conglomerate. HP-8 site is located in the north-west side of the Tashkent trough which axis goes from north-east to south-west. Sediments belong to silt sandstone. As to geomorphology, the HP-8 site is located on the accumulative plain of the second terrace above flood-plain of the Chichik River. The site surface is relatively plain. As to lithological composition with the depth explored down to 26.0 m, the site is bedded with hard-head gravel covered with thin loam deposits and artificial soil which depth is 0.3- 2.8 m. Loam soils are dust-colored, macroporous, wet with inclusion of lime kankars and gravel stones. Values of bulk density of naturally wet soil vary from 1.65 to 2.05 tons/cubic meter (m^3). Coarse deposits include pebble-stones and sand-and-gravel boulders. Pebbles and boulders came from abyssal and metamorphic rocks. Thickness of deposits is over 40.0 m. Bulk density is 2.1-2.2 tons/m^3. Natural angle of above-water slope is 40^o, and 30^o under water. Module of total gravel deformation – 500 kg/cm^2, permeability coefficient is 153-204 m^3/day. Ground waters are revealed at a depth of 1.5-2.9 m; since amplitude of ground water level variation during a period of maximum is 1.7 m, it is necessary to provide for drainage arrangements with a drainage rate of 0.5-1.0 m below a foundation base. According to chemical tests, ground waters have hydrocarbonate, sulfate, and calcium-magnesium composition with solid residue of 459.0-600.0 mg/l. Non-aggressive to concretes of any trademarks. Soil conditions in terms of its subsidence are characterized as type 1. Thickness of seasonal soil freezing is 0.7 m.

Soil and vegetation. Soil in the area of city boiler-houses belong to typical grey soils with evident signs of gritty consistency associated due to the presence in soil of coarse fragments and pebbles of mountainous massive rocks. Based on research, the soil cover in the Sergeli HP-8 area is characterized by minor soil pollution with lead and cobalt all over the place, and local minor pollution with zinc, chrome, and copper. There is no soil pollution with such elements as cadmium, uranium, selenium, and arsenic. Vegetation in the Sergeli HP-8 area is conditioned by effects of current impact sources. According to vegetation composition analysis, the area of HP-8 has such trees as thuja, ash-leaved maple (*Acer negundo*), eastern plane, and fruit-bearing plants: apple trees, cherry trees, peach trees, nut trees, and grapes. Visual inspection revealed insignificant dustiness of leaves.

Current status of environmental pollution. Conducted environmental assessment in the HP-8 area shows that in terms of climate factors for air pollutant dispersion the area of the projected plant is one of the most favorable in the region. Annual average concentrations of pollutants for the last three years did not exceed maximum permissible levels. Air pollution level is assessed as moderate. Concentration of pollutants in the ground water does not exceed sanitary standards. Ground water has a permissible level of pollution. Soils belong to typical grey soils with low conservation and high washability, which contributes to pollution of subjacent bedding rocks. They have rather high levels of toxic elements significantly exceeding maximum permissible levels and background values for soils in Tashkent oblast. Soil condition in the Sergeli HP-8 area should be recognized as satisfactory. Quality indicators of groundwater pollutants also do not exceed maximum permissible levels. Toxicological-hygienic assessment has shown an acceptable pollution level and acceptable health hazard level. Visual monitoring of vegetation proves its good growth in the area of Sergeli HP-8.

Social and economic conditions. Currently, Sergeli HP-8 provides heat for consumers of the industrial zone and urban residential areas – Sergeli, Sputnik, and Dustlik. Population of the Sergeli urban area is 143,600 people and they mainly reside in multi-storey apartment buildings, although there are some private houses.

3.3.3. Analysis of project alternatives

Technological options. The main goal of the project is to organize Sergeli HP-8 as a closed heating system through modernization of utility heating system for Sergeli district and to arrange such a heating system that would ensure full and high-quality uninterrupted heating of all consumers and minimize energy generation and transportation losses. The following options have been considered in developing a heating system modernization project in Sergeli district:

- To create a modern resource-efficient system to provide high-quality and uninterrupted heating and hot running water to population and social facilities from the currently existing boiler-house of Sergeli HP-8 through modernization and overhaul of existing boilers, replacement of supporting equipment with modern resource-efficient technologies, introduction of a computerized process control system for boilers and a heat generation and consumption metering system;
- To reorganize the existing open heating system into a close one which will allow saving up to 30% of hot water;

- To introduce a modern automated heat metering system at all stages – from its generation to its use by consumers;
- To protect environment through reducing fuel consumption at energy sources and makeup water consumption in the process of introducing of a closed heating system;
- To lower costs of water chemical treatment through the introduction of a closed heating system;
- To reconstruct separate sections of water distribution networks to supply water to individual heating substations (IHS) and install additional pumps at existing water pumping stations;
- To use solar heaters for hot water supply in summertime;
- To replace exhausted sections of above-ground and underground heat-supply networks;
- To reconstruct specific sections of water distribution networks with replacement of pumping equipment and installation of extra pumps at water pumping stations.

Location options. The Sergeli HP-8 area is characterized by availability and affordability of production and transportation infrastructure. Power, natural gas, and water will be supplied directly from existing municipal networks. The existing infrastructure and qualified staff can be used. Other location alternatives have not been considered.

Zero option. In case of abandoning reconstruction and modernization of the Sergeli HP-8 heating system, it will deprive the population in the Sergeli area of the opportunity to receive heating and thus this option was rejected.

3.3.4. Impact Assessment

Air pollution. To assess potential project impact on pollutant emissions it was estimated the current and after the project implementation emissions from the district heating system, - presented in *table 23* and *table 24* below.

Table 23. Current parameters of air pollutant emissions

Plant	*Unit*	*Sources of pollutant emissions*		*Work hours per year*	*Substance*	*Diameter of a pipe orifice (m)*	*Pollutants emissions*	
		Item	*Number (pieces)*				*g/sec*	*tons per year*
HP-8 boiler-house	Boiler-house	GMWH-100	2	7200	Carbon monoxide Nitrogen dioxide Nitrogen oxide	5.4	28.530 10.552 1.71	739.568 273.528 44.448
		GMWH-100		2160	Carbon monoxide Nitrogen dioxide Nitrogen oxide Sulfur dioxide Soot Vanadium pentoxide		19.07 3.10 0.5 84.06 1.47 0.022	148.37 24.16 3.925 653.63 11.5 0.175
		MPLWH-50	1	8400	Carbon monoxide Nitrogen dioxide Nitrogen oxide	2.5	12.819 4.74 0.77	387.65 143.37 23.297
		MPLWH-50	1	8400	Carbon monoxide Nitrogen dioxide Nitrogen oxide	2.5	12.819 4.74 0.77	387.65 143.37 23.297
		UDCWT 6.5/13	2	2160	Carbon monoxide Nitrogen dioxide Nitrogen oxide	0.6	1.14 0.37 0.061	8.890 2.916 0.473

Table 24. Projected parameters of air pollutant emissions

Plant	*Unit*	*Sources of pollutant emissions*		*Work hours per year*	*Substance*	*Diameter of a pipe orifice (m)*	*Pollutants emissions*	
		Item	*Number (pieces)*				*g/sec*	*tons per year*
HP-8 boiler-house	Boiler-house	GMWH-100	2	7200	Carbon monoxide Nitrogen dioxide Nitrogen oxide	5.4	15.915 5.88 0.954	412.54 152.57 24.790
		GMWH-100		2160	Carbon monoxide Nitrogen dioxide Nitrogen oxide Sulfur dioxide Soot Vanadium pentoxide		2.861 0.467 0.075 12.64 0.222 0.0034	22.253 3.634 0.590 98.33 1.73 0.026
		MPLWH-50	1	8400	Carbon monoxide Nitrogen dioxide Nitrogen oxide	2.5	7.0179 2.720 0.444	214.087 82.496 13.400
		MPLWH-50	1	8400	Carbon monoxide Nitrogen dioxide Nitrogen oxide	2.5	7.0179 2.720 0.444	214.087 82.496 13.400
		UDCWT 6.5/13	2	2160	Carbon monoxide Nitrogen dioxide Nitrogen oxide	0.6	0.128 0.1 0.016	2.29 0.78 0.120

Analysis of data presented in these tables show significant reduction in pollutant emissions which will lead to an improvement of air quality and respectively in health of the local population.

To assess HP-8 Sergeli impact on the city air it was made a calculation for the use of gas and mazut by applying the "ECOLOG" software. In the results it was calculated pollutant concentration for the area 0.7 km*0.5 km with a step of 50.0 m. Parameters of emission sources are defined on the basis of equipment performance indicators and summarized in *table 25* presents the hazardous substances discharged during operations by using natural gas.

Table 25. Current characteristics of air pollutants (with the use of natural gas)

№	*Substance*	*MPL or SRLI (mg/m^3)*	*Hazard rating*	*Established quota (share in MPL)*	*Maximum concentration at the boundary of an enterprise (MPL share)*	*Conformity with the established quota (+/-)*	*Total emissions (tons/year)*	*Share of total emissions (%)*
1	Nitrogen dioxide	0.085	2	0.20	0.10	+	317.562	26.25
2	Nitrogen oxide	0.4	3	0.25	0.00	+	51.59	4.26
3	Carbon monoxide	5.0	4	0.33	0.00	+	840.714	69.49

According to the calculations of air pollutant emissions due to operations with the use of natural gas, maximum concentrations of nitrogen dioxide at the boundary of an enterprise do not exceed the established quota of 0,2 MPL. Maximum concentrations of carbon and nitrogen oxides are lower than the established quotas. The data in the case of use of mazut are presented below in *table 26.*

Table 26. Current characteristics of air pollutants (with the use of mazut)

№	*Substance*	*MPL or SRLI (mg/m^3)*	*Hazard rating*	*Established quota (share in MPL)*	*Maximum concentration at the boundary of an enterprise (MPL share)*	*Conformity with the established quota (+/-)*	*Total emissions (tons/year)*	*Share of total emissions (%)*
1	Nitrogen dioxide	0.085	2	0.20	0.19	-	169.406	
2	Nitrogen oxide	0.6	3	0.25	0.001	+	50.992	
3	Carbon monoxide	5.0	4	0.33	0.01	+	452.717	
4	Sulfur dioxide	0.5	3	0.25	0.00	+	98.33	
5	Soot	0.15	3	0.25	Total max <0.1*	+	1.73	
6	Vanadium pentoxide	0.002	1	0.17	Total max <0.1*	+	0.026	

Table 27 presents BH impact on ambient air quality currently and under the project provided that solar plant is installed.

Table 27. BH impact on air quality

Pollutant	*Gross pollutant emissions, tons/year*			
	Currently		*Under the project*	
	With the use of natural gas	*With the use of mazut*	*With the use of natural gas*	*With the use of mazut*
1	2	3	4	5
Carbon monoxide	1517.86	932.56	840.714	452.717
Nitrogen dioxide	560.26	313.81	317.562	169.406
Nitrogen oxide	91.042	50.992	51.59	27.51
Sulfur dioxide		11.5		1.73
Soot		653.63		98.33
Vanadium pentoxide		0.175		0.026
Total	2,169.162	1,962.667	1,209.866	750.621

Table 28 below shows that impact intensity will decrease by 959.3 t/year for natural gas and by 1,212.046 t/year for mazut.

Table 28. BH impact on air quality and gross emissions currently and under the project

Pollutant	*Gross pollutant emissions, tons/year*								
	Up to date				*Under the project*				
	With the use of natural gas		*With the use of mazut*		*With the use of natural gas*		*With the use of mazut*		*Quota, share of MPL*
	Estimated maximum concentration on the enterprise's boundary (share of MPL)	Sources with highest share in maximum concentration, %	Estimated maximum concentration on the enterprise's boundary (share of MPL)	Sources with highest share in maximum concentration (%)	Estimated maximum concentration on the enterprise's boundary (share of MPL)	Sources with highest share in maximum concentration (%)	Estimated maximum concentration on the enterprise's boundary (share of MPL)	Sources with highest share in maximum concentration (%)	
Carbon monoxide	0.01	№9-49.35 №10-47.35	0.03	№11-99.68	0.01	№9-49.4 №10-47.57	0.01	№11-99.97	0.33
Nitrogen dioxide	0.19	№9-49.17 №10-47.59	0.6	№11-99.2 №9-0.41 №10-0.38	0.10	№9-49.06 №10-47.61	0.19	№11-41.26. №9-29.08 .№10-27.73	0.2
Nitrogen oxide	0.01	№9-49.4 №10-47.36	0.02	№11-99.38	0.01	№9-49.14 №10-42.57	0.01	№11-96.24	0.25
Sulfur dioxide	-	-	0.01	№1-100	--	-	0.00	№1-100	0.25
Soot	-	-	Total max <0.1*	№1	--	-	Total max <0.1*	№1	0.25
Vanadium pentoxide	-	-	Total max <0.1*	№1	--	-	Total max <0.1*	№1	0.17

The *table 28* shows that nitrogen dioxide impact will decrease by 0.09 MPL if fueled with gas and by 0,4 MPL if fueled with mazut, carbon oxide will decrease by 0.02 MPL for mazut and by 0.01 MPL for natural gas. Impacts of other substances will also decrease by 0.01 MPL. As the level and area of air pollutant impacts are insignificant, reconstruction and modernization of Sergeli HP-8 boiler-house will have a little impact on human health, soil, and vegetation.
During various civil works, there will be other pollutant emissions - from welding units and a diesel-powered erecting crane and in particular non-organic dust, iron oxide, silicon compounds, welding aerosol, manganese and its compounds will be the main pollutants. All these emissions are short-time, and insignificant.

Overall it is possible to conclude air pollutant emissions of Sergeli HP-8 are insignificant, and according to pollutant dispersion calculations, maximum pollutant concentrations do not exceed the established quota.

Underground and surface water consumption and pollution. Sergeli HP-8 boiler-house will not impact hydrological behavior of underground and surface waters in terms of water consumption. Water will be used from municipal water supply and distribution system. For boiler-house operations, water consumption will amount to 17,670.2 m^3/day (6,184.570 thousand m^3/year). Boiler-house's technical and domestic wastewater amounts to 407.45 m^3/day (142.607 thousand m^3/year), of which industrial wastewater (393.35 m^3/day or 137.672 thousand m^3/year) flows into Shokir-arik and domestic water (14.1 m^3/day or 4.940 thousand m^3/year) flows into the municipal sewerage network. Start-up operations of boiler-houses after reconstruction works will not impact the surface water as they use water from the municipal water-supply system. There is no discharge of pollutants into the surface water. Wastewater from boiler-houses (407.45 m^3/day or 142.712 thousand m^3/year), of which technological wastewater – 393.35 m^3/day (137.672 thousand m^3/year), flows into Shokir-arik, domestic wastewater (14.1 m^3/day or 4.9404 thousand m^3/year) flows into the municipal sewerage system.

After reconstruction works, boiler-house operation requires technical water for technological and domestic needs. Water consumption for technological needs makes up 17,635.96 m^3/day (6,172.586 thousand m^3/year). Water consumption for domestic needs is 14.1 m^3/day, for area sprinkling – 4.63 m^3/day, and for irrigation of trees and plants – 12.3 m^3/day. Total water consumption will amount to 17,666.93 m^3/day (6,183.425 thousand m^3/year). Water will be withdrawn from the municipal water-supply network.

Water consumption prior and after reconstruction is presented in *table 29* and water consumption will be reduced because there will be less water used for maintaining water chemical treatment plants.

Table 29. Water consumption

Types of water consumed	Currently		Under the Project	
	m^3/hr	m^3/day	m^3/hr	m^3/day
Water for technical needs, single water filling of heating networks, adding of water, washing of containers	1,049.3	26,263.8	734.83	17,635.96
Domestic needs	0.38	9.124	0.58	14.1

In terms of waste water, the conducted analysis shows also a significant reduction in its discharges, see *table 30*.

Table 30. Wastewater Characteristics

Plant, unit	Wastewater discharge				Pollutant	Pollutant concentration (mg/dm^3)	Pollutant quantity (kg/day)	Frequency of water discharge	Location of wastewater discharge
	Currently		Project						
	m^3/hr	m^3/day	m^3/hr	m^3/day					
Industrial waste water	35.34	848.192	16.38	393.35	Conventionally clean			Periodically	Discharged in Shokir-arik
Domestic waste water	0.38	9.124	0.58	14.1	Domestic			Permanently	Discharged into municipal sewerage system

Waste generation. During the project implementation it will be generated a series of different types of wastes: metal pipes, non-asbestos mineral wool, asphalted felt, replaced boilers, construction wastes and lining materials. Waste metal pipes are transported to 'Vtorchermet' for recycling, dismantled boilers are transported to 'Vtorchermet', lining materials, technical oil, asphalted felt and mineral wool are also subject to recycling. The *table 31* below shows the types and amount of such waste that will be generated by the project. Overall can be concluded these wastes may be a source for soil decontamination only in case of violation of their reloading and storage conditions. The project proposes the waste materials to be stockpiled and stored in an adequately equipped site for their temporary storage, after which to be shipped to the city landfill.

Table 31. Waste generation and characteristics under the project

#	Item	Location	Physical and chemical qualities				Standard quantity	Container, package	Disposal, decontamination methods
			Physical state, density (kg/m^3)	Share of main components, % mass.	Dissolubility	Volatility	Tons per year		
1	Waste pipes	Mainline	solid	Steel 20	insoluble	Non-volatile	2501.7		Vtorchermet
2	Waste mineral wool	Mainline	solid	SiO_2-35-60 Al_2O_3-39-55 CaO-0-35 MgO-0-30	insoluble		27.9		Reprocessing
3	Waste asphalted felt (ruberoid)	Mainline	solid	Bitumen, talc, talc-magnesite	insoluble		86.0		Reprocessing
	Burners	Boiler	solid	Steel	insoluble				Vtorchermet
4	Gland seals	Turbine building	solid	Graphite, foam plastic	insoluble		0.072		Solid domestic waste
	Waste gaskets	Turbine building	solid	Paronite	insoluble		0.144		Solid domestic waste
	Waste technical oil	Turbine building	liquid	TP-22, I-40 oil	insoluble		0.29		Oil depot
	Waste rubber	Turbine building	solid	Rubber	insoluble		0.017		Solid domestic waste

Impact on soil. In terms of long-term impact of all pollutants discharged by Sergeli HP-8, their concentration in soil is not expected to exceed the established MPL. Soil damaged during replacement of heating pipelines will be recultivated. Long-term impact of all hazardous components from boiler-house operations is not expected to exceed the established MPL.

Impact on vegetation. Species composition and plant productivity may be impacted by natural and man-made factors, although maximum ground-level concentrations of pollutants are significantly lower than those resulting in vegetation damage. Moreover, nitrates discharged in soil are a biogenic element and they are engaged in vegetation protein metabolism contributing to their growth. Additional planting provided under the project will improve microclimate in the territory of the boiler-house. Therefore, there will be no negative effect on the vegetation.

Construction traffic. The transportation activities and traffic could lead to traffic congestion and inconvenience to the public due to: (i) increased vehicles for materials and solid wastes transportation, and (ii) deterioration of the roads condition after asphalt milling and excavation and leveling. It might bring negative effects to the narrower road and cause larger vehicle flux.

Noise and vibration. The following construction works will produce noise: (a) Foundation construction and concrete mixing; (b) Assembling of steel construction units and installation of equipment; (c) Site cleaning and putting boiler-houses into operation; and (d) replacement of burners. Noise will not exceed permissible norms, provided that properly functioning equipment is used. It is also expected noise in the area of nearby residential buildings will not exceed the admissible level according to construction norms and regulations 2.01.08-96.

Health and safety impact. Personnel health will not be impacted provided that occupational safety and health rules are introduced and followed. Reconstruction and modernization of boiler-houses will enable to meet the people's needs in heat and hot water. Operation of company's boiler-houses in compliance with technical and occupational safety rules will have no significant environmental impact and have positive impact on human social situation.

Potential labor safety issues. The following determines potential injuries and health damage in the boiler-house: (a) Substances of hazardpus substances; (b) Electric shock hazard; (c) Heat injury hazard; and (d) Injury by motion parts of equipment. All these may couse potential accidents and together with computed maximum sizes of damage zones and casualties they are presented in *Table 32*. Damage zones of potential accidents do not spread over the plant area and do not reach the adjacent human settlement. All possible hazard sources are not classified as potentially hazardous, and possible accidents are not considered major as expected irrevocable casualties are less than 1 person (*table 33*).

Table 32. Major physical, chemical and explosion/fire hazard characteristics of pollutants

Item	*General description*	*Density(kg/m^3)*	*Temperature, ^oC*			*Explosive limits, %*		*Hazards (for humans)*	*Maximum permissible concentration in the air of an operational zone of industrial facilities, mg/m^3*
			Flash-point	*Ignition*	*Spontaneous inflammation*	*Lower limit*	*Upper limit*		
Natural gas	Colorless gas with specific smell	0.717	–	–	530	5.5	14	Hazard classification – 4. Narcotic action; high concentration causes asphyxia	300

Table 33. Potential accidents and their consequences

№	*Accident location and scenario*	*Substance*	*Size of damage zone, m*				*Human casualties (number of people)*		*A priori frequency of accidents per year*
			Irrevocable		*Sanitary*		*irrevocable*	*sanitary*	
			Radius or length	*Width*	*Radius or length*	*Width*			
	Gas pipeline								
1.	Fire	Natural gas	4.14		18.75		0.03	0.55	10-6

Noise. Noise of boiler-house will not exceed 80 dBc in the working area.

Socio-economic environment. There will be no impact on personnel health, provided that occupation safety and health rules are introduced and followed. Reconstruction and modernization of the boiler-house will enable to meet the needs in heat and hot water of the Sergeli district.

3.3.5. Environmental Mitigation Plan

The proposed mitigation measures are similar to those presented above in point 3.1.5. The *Table 34* presents an action plan to mitigate environmental impact adapted to the project activities in Sergeli district of Tashkent city.

Table 34. Action plan to mitigate HP-8 environmental impact

Process resulting in environmental impact	*Environmental impact features*	*Environmental impact duration Local/continuous*	*Measures to reduce environmental impact*	*Institutional responsibility*
1	2	3	4	5
Impact during reconstruction of the city heat and hot water supply system				
1. Replacement and reconstruction of pumping equipment	Waste accumulated during dismantling of equipment and construction units; air pollution during demolition and removal of equipment and construction units, and welding works during dismantling phase; noise as a result of working equipment; labor safety	Local – phase of construction works	Separation of all wastes accumulated during dismantling of equipment and construction units and their shipment to city landfill or to enterprises collecting ferrous wastes; strict control over the use of motor vehicles and construction equipment in accordance with established standards; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	Management of the contractor
2. Solar plant construction	Emissions during welding operations; construction waste; noise	Local – phase of civil works	Proper construction waste management; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	Management of the contractor
3. Reconstruction of main and distribution heat pipe networks	Emissions during dismantling of old heat networks (welding equipment, motor vehicles); new heat supply networks require trench works and installation of concrete beds – air pollution with fuel combustion products from equipment, dust emission; soil damage; possible cutting down of trees; emissions due to welding works during installation of pipelines; labor safety	Local – phase of construction works	Distribution of all wastes accumulated during dismantling of heat networks among enterprises specialized in their disposal and storage; strict control over the use of motor vehicles and construction equipment in accordance with established standards (during dismantling and construction works); selection of the optimal route for heat networks; involvement of highly qualified specialists to minimize consumption of welding materials; preserving of soil removed during pipeline construction for its further use for leveling.	Management of the contractor

4. Installation of Individual Heating Stations	Emissions during civil works; construction waste generation; noise; air pollution with dust; labor safety.	Local – phase of civil works	Proper construction waste management; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc. .	Management of the contractor
5. Replacement of existing burners with the modern ones	Emissions during welding operations; construction waste; noise	Local - temporary	Proper construction waste management; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	Management of the contractor
6. Construction of transformer substations and power supply networks	Emissions during welding operations; construction waste; noise, potential tree cut	Local temporary	Proper construction waste management; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	Management of the contractor
Impact during operation				
Heat and hot water supply to consumers	Air pollution due to operation of BHs; water consumption and contaminated water discharge; industrial wastes due to maintenance and overhaul of boiling equipment	Continuously – during operation	To reduce air pollution, the project provides for the use of new energy and cost efficient gas-fueled condensation boilers; water consumption and discharge will be reduced through the introduction of a closed heat supply system and construction of individual heating substations in residential and public buildings; distribution of all wastes accumulated during maintenance works among enterprises specialized in their disposal and storage; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	District heating company

3.3.6. Monitoring and supervision plan

In order to ensure efficient implementation of the mitigation measures proposed, including compliance with environmental requirements during the construction stage, a program of monitoring activities will be required (see it below in *table 35*). Inspections of construction sites are among the duties of the district heating authorities' staff and are covered form their budgets. The impact monitoring on water and air quality, noise, etc., will be done by Contractors and periodically by district heating company. Costs for monitoring activities during the Project construction phase should be included in the bill of quantity for proposed civil works.

Table 35. Monitoring of EMP implementation

Project activity /Mitigation Measure	*Where* *(is the parameter to be monitored?)*	*What* *(is the parameter to be monitored?)*	*How* *(is the parameter to be monitored?)*	*Who* *(is responsible for monitoring?)*	*When* *(define the frequency / or continuous?)*	*Cost/sources of financing*
1	2	3	4	5	6	7
1. Replacement or exhausted pipelines of heat supply pipelines/ Soil protection; Prevention of air emissions from vehicles and equipment and watering for dust prevention; Noise prevention through calibration of equipment and working during daily time hours; Construction waste management – their collection, separation and disposal; Potential tree loses; Ensuring labor safety.	Pipeline route	Emissions/smoke from vehicles and working equipment; Dust; Expenditures.	Visual monitoring; Expenditures for watering	Contractor	Daily	Contract-based
		Soil protection/ volume of excavated and/or recultivated soil (m3)	Data on implemented works and on related expenditures	Contractor	Weekly	Contract-based
		Waste/type and weight; associated expenditures	Contractor data on collected, separated, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract-based
		Noise/level of noise in DbA	Instrumental measurements	Contractor; Sanitary inspection	Weekly	Contract based; District heating company resources
		Number of trees cut	Expenditures for tree cut	Contractor; District heating company	Monthly	District heating company resources
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources
2. Solar plant construction / equipment emissions; Construction waste; noise	Construction site	Emissions / dust and welding pollutants	Visually	Contractor	Daily	Contract based
		Noise / DbA	Observations	Contractor; Sanitary inspection	Weekly	Contract - based

		Waste / type and weight, expenditures	Contractor data on collected, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract - based
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources
3. Replacement of existing burners with the modern ones / equipment emissions; Wastes; Noise; Ensuring labor safety	BH	Emissions / dust and welding pollutants	Visually	Contractor	Daily	Contract based
		Noise / DbA	Observations	Contractor; Sanitary inspection	Weekly	Contract - based
		Waste / type and weight, expenditures	Contractor data on collected, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract - based
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources
4. Construction of transformer substations and power supply networks / equipment emissions; Wastes; Noise; Ensuring labor safety	Construction site	Emissions / dust and welding pollutants	Visually	Contractor	Daily	Contract based
		Noise / DbA	Observations	Contractor; Sanitary inspection	Weekly	Contract - based
		Waste / type and weight, expenditures	Contractor data on collected, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract - based
		Occupational safety/number of	Accident register;	Contractor;	Weekly	Contract based;

		accidents; conducted specialized training, number of participants and provided protective closes	Training register; Expenditures for protective closes	District heating company		District heating company resources
5. IHS construction / Prevention of dust and emissions from equipment; Noise prevention; Construction waste management; Ensuring labor safety	Residential buildings	Emissions/dust and equipment emissions	Visual monitoring	Contractor	Once	Contract-based
		Noise/level of noise in DbA	Instrumental measurements	Contractor; Sanitary inspection	Weekly	Contract based; District heating company resources
		Waste/weight	Contractor data on collected, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract based; District heating company resources
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources

3.3.7. State Ecological Expertise approval.

The EIA&EMP study for HP – 8 of Sergili district of Tashkent city has been submitted for its review and approval to the State Committee for Environmental Protection (State Ecological Expertise) and on October 24, 2014 it has been officially approved (Decision No. 18/1204). The SEE decision specifies overall the EA report is of good quality and corresponds to all national environmental requirements. The document also mentions the next EA step should be presenting to the SEE before putting in operation the district heating is the Declaration on environmental impacts along with the all necessary environmental permits and licences (in particular for air emissions, for waste water discharges, waste management). It is also indicated the Tashkent Committee for Environmental protection will keep under control and supervise implementation of all environmebntal requirements, specified in the EMP.

3.4. EIA & EMP for Bukhara city

3.4.1. Current status of city's district heating system and proposed investments.

The current heat supply system in Bukhara is open meaning that hot water from DH network is directly used for heating and providing hot water. For the present, heat supply and hot water supply of the consumers of Bukhara city is carried out by boiler houses of two large producers of heat power:

1.-OJSC «Bukharaenergomarkaz» - 223.0 *10^3Gcal/hour;
2.- OJSC «Issiklik manbai» - 324.5 * 10^3Gcal/hour.

Besides there are objects -57 apartment houses which are not connected to district boiler houses as before they belonged to various departments abolished nowadays and were supplied with heat by the departmental boiler houses liquidated now.

"BEM" is operating entity with the developed infrastructure. It is located in the southeast of the industrial zone, in 7,5 km from the center of Bukhara - to the south of the main road Tashkent - Bukhara. For the present, OJSC Bukharaenergomarkaz operates steam GM-50/14 boiler units with the productivity of steam of 35 Gcal/hour with pressure of 14 kgf/cm2 in amount of 7 pieces (are placed in the boiler workshop), and water-heating KVGM-50 boiler units with the productivity of 50 Gcal/hour, with the temperature of hot water of 70 - 150 °C, in amount of 4 pieces (are placed in the water-heating workshop) installed during the period from 1973 to 1987. The equipment is operated according to the operating schedules and is in normal technical condition.

"IM" - the operating entity including the consumers of heat power placed in the centers of localization, 39 boiler houses of various capacity with the developed infrastructure.

The production infrastructure of OJSC "Bukharaenergomarkaz" and OJSC "Issiklik manbai" is created at construction and operation of boiler houses and provides normal operation of the equipment, has the appropriate connections to the city engineering - communication networks of power supply, water supply, sewerage, etc.

Fuel supply of OJSC "Bukharaenergomarkaz" and OJSC "Issiklik manbai" is provided with natural gas from the nearby Bukhara deposit (Qrn = 8276,4 kcal / nm3), supplied by the existing city communications from "Garbgaztaminot" entity.

Water supply of "BEM" and "IM" is carried out from the city water supply system providing filling and supply of boiler units and the system of domestic and drinking water supply.

The sewerage - the industrial sites of "BEM" and boiler houses of "IM" are equipped with the following sewerage systems: production; domestic and household.

The project investments will deal with the DH system of Bukharaenergomarkaz and would include the following:

(a) Installation of two new gas-fired boilers with total capacity of 75 MW, which is sufficient to meet the current heat demand.

(b) Replacement of about 22.5 km (one-pipe length) of DH network.

(c) Installation of 408 IHS to serve residential and public buildings connected to the DH system. Substations shall be modern, fully automated, and equipped with heat meters for billing purposes.

(d) Electricity network reconstruction. This will include laying cable lines (6 kV and 0.4 kV), and construction of new substations (no old transformers will be replaced).

(e) Maintenance tools and vehicles for the BEM and IM district heating companies. This will include special maintenance vehicles and typical mechanical and electric maintenance equipment.

Transition to the closed system of heating and hot water supply with installation of individual heating points will allow to eliminate defects of the open system of heat supply, will provide the real border of the areas of responsibility for the used energy resources between the Producer and the Consumer of heat power, will result in real saving of energy resources.

A closed heating system with the use of individual heat substations will have some advantages against the existing heat supply system:

- Energy consumption for water pumping is reduced by 20~40%;
- Because of automated regulation of heat supply to a consumer (building), up to 15% of heat will be saved;
- Heat losses due to hot water transportation will be halved;
- Number of heat network accidents will be significantly reduced if hot water supply pipelines are excluded from the networks;
- Heat comfort in buildings is maintained automatically through controlling of the following parameters: temperature and pressure of heating and running water; indoor air temperature (in monitored locations) and outdoor temperature;
- Payment for heat consumption by each building is based on actually measured consumption due to the use of metering devices;
- Significant cost reduction for in-house heating systems due to the use of pipes with a smaller diameter and non-metal materials;
- Heat will be saved and cost of installation works will be reduced as equipment will be fully assembled by manufacturers. Heat saving will be around 20~30%;
- Feed water costs will be reduced and consequently water treatment costs will be reduced as well.

3.4.2. Baseline analysis

Climatic Conditions. Climate of the region - dry semi-desert with the increased wind activities. Only 16-17 days per year are windless. During the vegetative period hot dry winds (garmsil) are observed, especially in July-August when air temperature rises to 38-40^0, and relative humidity of the air decreases to 10-15%. All this results in high evaporability which averages 1292.6-1504.5mm for the vegetative period. Duration of no-frost period is on average 217 days. Duration of the vegetative period with air temperatures of +10^o and above makes 228–242 days with the sum of effective temperatures of 2458 - 2827 ^{o}. The first

autumn frost is from October 14 to November 2, and the last spring one is in March 15 - 16. Stable average daily air temperatures above 10^{o} occur during the period from March 14 to March 21. Relative humidity of the air averages 56% during the vegetation. The lowest relative humidity of the air is observed in July-August (37%). Fogs and dust storms refer to adverse atmospheric conditions.

Surface water and its quality. The water resource of Bukhara region consists of the network of canals (Amu-Bukhara canal, Kuimazar canal, Khayrabad canal, Zeravshan canal, Shakhrud canal) passing on the territory of the region. The Zarafshan river with Fandarya, Iskanderdarya, Kshtutdarya and Magiandarya tributaries is the main water source of the basin. Length of the river makes 877 kilometers, the area of the basin is 12300 sq.km, average water discharge per second is 164 m3. In addition to the Zarafshan river, the main superficial waterway of the region is Amu-Bukhara canal. Length of the canal makes 197 kilometres, the irrigated area is 269 thousand hectares, water consumption per second is 150 m^3. The oxygen mode of Shakhrud, Zerafshan canals and Avgir aryk is considered satisfactory. The pH value does not change and keeps at the level of 6,7-7,9. In general, the content of sodium, potassium, magnesium, chlorine, calcium, zinc, fluorine, arsenic, sulphate in water bodies does not exceed the sanitary standards. The mineralization and amount of the suspended substances remains normal. Pollution of the canal with pesticides is at the level of 0,028-0,038 mkg/l (2,8-3,8 maximum allowable concentrations). Availability of DDT and its metabolites is not noted. Water quality refers to the III class of moderately polluted waters by the index of water pollution. By hydrobiological indicators environmental condition of some parts of superficial waterways is satisfactory.

Thus, environmental condition of the superficial waterway flowing near the location of the enterprise is satisfactory by hydrobiological signs, by hydrochemical indicators, surface waters are referred to the III class of moderately polluted waters.

Ground waters. According to the data of regional irrigating management system, ground waters differ by low mineralization in the most part of the irrigated lands of Bukhara region. The lowest mineralization of ground waters is noted in Vabkent, Gijduvan and Romitan districts. In the Bukhara oasis to the periphery and from the upper part of the delta to the southwest the mineralization of ground waters increases. More highly mineralized ground waters are in the southwest suburb of the oasis in the area of saline depressions.

Bukhara region has rather low degree of drainage. In addition to drainage the level of ground waters is influenced by water supply. According to the Bukhara experimental station, at the depth of ground waters of 150-190 cm and increase in water supply from 4000m^3/hectare, every 1000m^3/hectare the level of ground waters increases by 10-15 cm. At the same time reduction of irrigation rate increases sharply the ground waters consumption for transpiration. During the vegetation period ground waters occur the deeper the less is water supply. Ground waters decrease especially sharply if two low-water years happen in a row. Level of ground waters in October-December fully depends on water supply during the vegetation period. On average per year the level of ground waters occurs at the depth of 2.5-3 meters. Ground waters occur the closest to the surface in March – April. Ground waters occur the deepest after the termination of vegetative irrigation in October-December.

The depth of ground waters in the studied section is 2.1-2.5 meters from the surface, in spring - summer period the level of ground waters can rise up to 1.8-2.0 meters as a result of

infiltration from the fields and losses from irrigation aryks (Avgir aryk). Mineralization of ground waters is up to 20 g/l. Sulphates prevail in the content of salts.

Soil quality. The soil cover in the area of the planned construction, is represented by the meadow and grey desert and meadow soils created in the conditions of unsecured water exchange of ground waters. Soil-forming rocks – medium and heavy loams, in interconical depressions - heavy loams and clays. Under the upper fine soil with the thickness of 2-4m clay or the condensed oozy sand with interlayers of clays, sandy loams and loams occurs. The mechanical structure of these soils (meadow saline) is characterized by the high content of fraction of coarse dust, as well as some enrichment by oozy fraction of upper and especially middle part of their profile that is caused by claying development. The mineralogical structure of the coarse fraction is generally represented by quartz, feldspars, hydromicas, and calcite. Chlorite, minerals of montmorillonite group, vermiculite and amorphous substances prevail in high-disperse minerals. Meadow and saline soils are generally heavy by mechanical structure and are subject to active processes of salinization.

The chemical composition of soils is closely connected with their mineralogical structure and is characterized by high content of SiO2 and insignificant one of iron, aluminium, calcium, magnesium. Soils of Bukhara region sometimes have the increased quantity of carbonates of calcium, contain more water-soluble salts. Salinization of soils is usually chloride-sulphate or sulphate-chloride. The content of humus is not high, absorption capacity is insignificant, pH of water suspension is 6.5-7.8. Depth of seasonal frost penetration in soil makes 0.32 meters. Soil is not subsident, refers to the second territory.

Seismic activity in the city's area is 8 on the Richter scale.

Flora and Fauna. Wood vegetation of Bukhara region is represented along with native species of vegetation also by the acclimatized species from other regions. Characteristic feature of vegetation is domination or essential participation of the ephemeral plants and ephemeroids adapted to the contrast mode of moistening typical for this area. Viviparous meadow grass, sedge, and bulbous barley dominate among the ephemeral plants. Poplar, elm, plane tree, ash-tree, and maple are very typical for the conditions of Bukhara region. Out of foreign species Gleditsia, ailanthus, sophora, mimosa, thuja are usual. Planting of various trees along the road – plane tree, poplar, Asian sumac, ash-tree, maples, sophora, thuja (rarer), is widespread in Bukhara region. Thus, the condition of vegetation in the area of the site is typical for the whole region.

Among the mammals of Bukhara region, such species of rodents as gophers, hamsters, voles, rabbits and jerboas are most widespread. Among the predatory species, such ones as bats, foxes, badgers and polecats are usually noticed in various adjacent areas. The data of the research testify to the fact that in some specified habitats such species as turtles, lizards, snakes, scorpions and spiders are often met. The same places (rocks and erosive trenches) are preferable habitats and nestings of the birds of prey, such as golden eagle, steppe eagle, griffon, harrier, kestrel and wild partridge. Larks and sparrows generally inhabit desert plains and are met in close proximity to the settlements.

Number of terrestrial and insectivorous birds, such as, pigeon, black grouse, bee-eater, desert warbler, wheatear, nightingales, larks and sparrows usually gather in the places of concentration of big herds of domestic animals, for example, cattle, horses and camels.

3.4.3. Analysis of project alternatives

For decrease of operating expenses and optimization of operating modes of heat sources the project provides heat supply of the objects located compactly, but at a big distance from regional boiler rooms that reduced considerably the reliability of heat supply to the specified objects. Considering the historically created layout of the city, provision of this category of consumers with heat and HWS at optimum rates for supply of heat power, as well as minimum production costs is possible only with installation of local boiler houses, as it is provided in this project.

The proposed closed system of heating and hot water supply with installation of individual thermal points will allow to eliminate defects of open system of heat supply the main one of which is considerable losses of the heat carrier (water) and as a result load work of the stations of chemical water treatment. Transition to the closed water supply system with installation of individual thermal points will allow to reduce water consumption to: 177.0 thousand m^3/year (decrease by 1599 thousand m^3/year) for the objects of OJSC "Bukharaenergomarkaz", 377.0 thousand m^3/year (decrease by 3399.1 thousand m^3/year) for the objects of OJSC "Issiklik manbai", total water consumption will make 554.0 thousand m^3/year, saving of fresh water - 4998.1 thousand m^3/year.

Consumption of fresh water "before reconstruction" made 5552.1 thousand m^3/year, after the reconstruction (transition to the closed system of heat supply) it will make 554.0 thousand m^3/year, increase in water consumption with commissioning of local and autonomous boiler houses will make 39.85 thousand m^3/year, total consumption of fresh water - 593.85 thousand m^3/year, saving in comparison with the situation "before reconstruction" - 4958.25 thousand m^3/year.

3.4.4. Impact Assessment

Air pollution. For determination of the impact of emission of these sources on the atmosphere of the area of placement of the entity, calculation using the program VEGA was made. Calculation was made for three options – option before reconstruction, option after reconstruction and option taking into account the proposed actions for decrease in emission of nitrogen oxides.

Table 36 List of Polluting Substances

Name of substance	MAC	Class	Quota	Emission t/year (before reconstruction)	Concentration in MAC shares	Emission t/year (after reconstruction)	Concentration in MAC shares	Emission t/year (activities)	Concentration in MAC shares
1. Sulphurous anhydride	0.5	3	0.25	2.5712	0.0013	2.4004	0.001	2.4004	0.001
2. Carbon oxide	5.0	4	0.33	602.314	0.0264	518.066	0.0181	518.066	0.0181
3. Nitrogen dioxide	0.085	2	0.20	134.474	**0.30**	115.6582	**0.27**	94.8672	0.16
4. Benzpyrene	0.00001	1	0.17	0.0003	0.0024	0.0005	0.0032	0.0005	0.0032
5. Nitrogen oxide	0.4	3	0.25	33.6178	0.0184	28.9079	0.0143	23.7109	0.0063
TOTAL:				**772.977**		**665.0302**		**639.045**	

Air will be also polluted with other substances (nonorganic dust, ferrous oxides, silicon and manganese compounds, and welding aerosol) mostly during civil works for replacing the old pipelines and construction of IHSs, although their environmental impact is considered as temporary and local.

Chemical substance emission and discharge into soil and vegetation. Air pollutants from boiler-house operations will not negatively affect soil and vegetation as their ground level concentrations are less than 0.0 MPL.

Impact on soil and land resources. In terms of long-term impact of all pollutants discharged by boiler-houses, their concentration in soil is not expected to exceed the established MPL. Soil impact would include its mechanical damage due to excavation and leveling works during replacement of pipes and foundation construction of mini boilers. Soil and groundwater impact can be also due to spillages of oil products used as fuel for motor vehicles and construction equipment.

Waste generation. The waste generated under the project includes metal pipes, non-asbestos mineral wool, asphalted felt, replaced boilers, and lining materials. According to waste classification by hazard categories, asphalted felt and mineral wool are included in Hazard Class 2. Waste metal pipes are transported to 'Vtorchermet' for recycling, dismantled boilers are transported to 'Vtorchermet', lining material, asphalted felt and mineral wool are also subject to recycling.

Impact on vegetation. Species composition and plant productivity may be impacted by natural and man-made factors although maximum ground-level concentrations of pollutants are significantly lower than those resulting in vegetation damage. Moreover, nitrates discharged in soil are a biogenic element and they are engaged in vegetation protein metabolism contributing to their growth. Additional planting of industrial sites under the project will improve microclimate in the territory of OJSC "Bukharaenergomarkaz" and OJSC "Issiklik manbai". Therefore, there will be no negative effect on the vegetation.

Construction traffic. The transportation activities and traffic could lead to traffic congestion and inconvenience to the public due to: (i) increased vehicles for materials and solid wastes transportation, and (ii) deterioration of the roads condition after asphalt milling and excavation and leveling. It might bring negative effects to the narrower road and cause larger vehicle flux.

Noise and vibration. The following construction works will produce noise: (a) Foundation construction and concrete mixing; (b) Assembling of steel construction units and installation of equipment; (c) Site cleaning and putting boiler-houses into operation. Noise will not exceed permissible norms, provided that properly functioning equipment is used. It is also expected noise in the area of nearby residential buildings will not exceed the admissible level according to construction norms and regulations 2.01.08-96.

Health and safety impact. Personnel health will not be impacted provided that occupational safety and health rules are introduced and followed. Reconstruction and modernization of boiler-houses will enable to meet the people's needs in heat and hot water. Operation of OJSC "Bukharaenergomarkaz" and OJSC "Issiklik manbai" boiler-houses in compliance with technical and occupational safety rules will have no significant environmental impact and have positive impact on human social situation.

3.4.5. Environmental Mitigation Plan

Mitigation of environmental impacts will include the following.

Measures to reduce air pollution. By the results of machine calculation which is made for determination of the impact of emission sources resulting from the carried-out reconstruction, it is possible to draw a conclusion that when using natural gas as a fuel, concentrations exceeding the quota, are observed only by nitrogen dioxide in the territory of the city. Total emission of nitrogen dioxide: before reconstruction - 134.474 tons/year, after reconstruction - 115.6582 tons/year (decrease in emission is caused by reduction of fuel consumption, due to increase in effectiveness of heat supply system). The maximum concentration of this ingredient observed outside the entity before reconstruction is 0.3 maximum allowable concentration (MAC), after the reconstruction - 0.27 MAC - exceeds the established quota (0.2 MAC), development of the actions aimed at decreasing in emission of this ingredient to the standard values is required.

Nitrogen oxide emissions can be reduced by reducing or liquidating "thermal" NO_x. This will be achieved by lowering maximum burning temperatures – recirculation gas, water and steam injections into a burning zone or forced air flow, and through two-stage fuel burning which lowers maximum temperature and oxygen concentration in the zone of maximum temperatures.

Water resources protection measures. With a view to protecting and preventing groundwater contamination and ensuring health and disease control in accordance with construction norms and regulations 2.04.02.-97 and SS 245-71 "For Waterworks", a series of measures are provided to eliminate risks of soil and groundwater contamination with domestic, fecal, and industrial discharges from the facility:

a) use of equipment, reinforced frames and pipelines resistant to corrosive effects of waste and underground water;
b) hydro-insulation for sewerage and water wells, chambers, and containers; and
c) antiseismic construction units.

Underground unit concrete is made of sulfate-resistant Portland cement. Outer surfaces of such units in touch with soil are double coated with hot bitumen. Strict control over tightness of the elements of water distribution networks could suffice to fully eliminate groundwater impact in the site area.

Canals, pits, etc. should have rolled waterproofing. Anticorrosive protection of the structures of buildings above the mark 0.00 is provided according to the requirements of KMK 2.03.11-96 "Protection of building constructions from corrosion". For total elimination of negative impact on ground waters of the site, strict supervision of tightness of the elements of water supply system and sewerage networks is enough.

Measures to reduce noise. Technological equipment and electric engines of pumping and ventilation equipment are the main sources of noise at the project site. It should be noted that in the process of project development it is necessary to provide for standard equipment that meet GOST 17770-72 requirements (vibration and noise reduction devices) and GOST 12.4.011-75 (vibration-isolating and absorbing devices).

The equipment should be placed in separate rooms, on vibratory bearings, connection to the systems through flexible inserts. According to the KMK 2.01.08-96 "Protection from noise" the entity won't have significant impact on forming of noise background in the area of placement. It

is possible to assume that functioning of the designed project won't have significant impact on forming of the noise background in the area of its placement.

Waste management. During the reconstruction, replacement and repair of the existing boiler units, replacement of the existing heating networks and their isolation, replacement of heating systems and heating devices directly in the served rooms are provided.

During the reconstruction, wastes of ferrous metals (boiler units, pipes of heating plants, stubs of welding electrodes), non-ferrous metals (electric motors), wastes of fettling and insulating materials are generated. It is impossible to determine the amount of the predicted wastes at this stage of designing, at the following stages of design the quantity and content of wastes will be specified.

To store waste and obsolete fluorescent lamps, the project should provide for a separate room equipped with an exhaust ventilation system which capacity per hour should be at least 10 times higher than the room space. Lamps should be stored in boxes; in addition, each lamp should be stored in an individual package made of corrugated cardboard. As this type of waste belongs to mercury-containing waste, it should be collected, stored, registered and transported in accordance with O'z RH 84.3.10: 2004 "Regulation on Handling Procedures for Mercury-containing Products in the Republic of Uzbekistan" and should be safely disposed with ultimate demercuration.

For efficient collection and storage of rubbish and domestic waste, the project shall provide for a separate site equipped with improved covers and special containers with a capacity enough for a 3-day waste, and control its timely transportation by utility service's special trucks. It shall be strictly prohibited to burn solid waste.

Layout activities. The places of boiler houses location are planned and improved, there is no need in additional planning actions.

Soil protection during earthworks. Series of measures shall be provided to protect and prevent soil from contamination on the project site in accordance with GOST 17.4.3.02-85 "Nature Protection. Soil" and GOST 17.5.3.06-85 "Nature Protection. Land Plots": Traffic should move only along constructed roads that ensures safe traffic environment and does not cause vegetation and soil damages.

Table 37. Mitigation plan

Process resulting in environmental impact	*Environmental impact features*	*Environmental impact duration Local/continuous*	*Measures to reduce environmental impact*	*Institutional responsibility for controlling implementation of safeguards*
1	2	3	4	5
Impact during reconstruction of the city heat and hot water supply system				
Reconstruction of existing district boiler-houses (DBHs) and installation of new gas boilers	Waste accumulated during dismantling of replaced equipment and construction units; air pollution during delivery and transportation of construction materials to the sites, welding works, concrete preparation works, and excavation works; noise as a result of working equipment; insufficient increase in water consumption – for personnel domestic and drinking needs; personal safety issues	Local – phase of construction works	Distribution of all wastes accumulated during dismantling of equipment and construction units among enterprises specialized in their disposal and storage; strict control over the use of motor vehicles and construction equipment in accordance with established standards; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	Management of a contractor engaged in reconstruction of DBH
Dismantling of local boiler-houses (BHs)	Waste accumulated during dismantling of equipment and construction units; air pollution during demolition and removal of equipment and construction units, and welding works during dismantling phase; noise as a result of working equipment; insufficient increase in water consumption – for personnel domestic and drinking needs; labor safety	Local – phase of construction works	Separation of all wastes accumulated during dismantling of equipment and construction units and their shipment to city landfill or to enterprises collecting ferrous wastes; strict control over the use of motor vehicles and construction equipment in accordance with established standards; maintenance of the reconstructed sites – leveling, planting of greenery; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	Management of a contractor engaged in dismantling of a local BH
Electricity network reconstruction: laying cable lines; installation of	Construction waste generation; noise; air pollution with dust; labor safety; soil damage; possible cutting down of trees; emissions due to welding	Local – phase of construction works	Proper construction waste management; strict control over the use of motor vehicles and construction equipment in accordance with established standards; maintenance of the reconstructed sites – leveling, planting of	Contractor management

transformers in existing transformer substations, and construction of new substations			greenery; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	
Reconstruction of main and distribution heat networks	Emissions during dismantling of old heat networks (welding equipment, motor vehicles); new heat supply networks require trench works and installation of concrete beds – air pollution with fuel combustion products from equipment, dust emission; soil damage; possible cutting down of trees; emissions due to welding works during installation of pipelines; labor safety	Local – phase of construction works	Distribution of all wastes accumulated during dismantling of heat networks among enterprises specialized in their disposal and storage; strict control over the use of motor vehicles and construction equipment in accordance with established standards (during dismantling and construction works); selection of the optimal route for heat networks; involvement of highly qualified specialists to minimize consumption of welding materials; preserving of soil removed during pipeline construction for its further use for leveling.	Management of a contractor engaged in reconstruction of heat pipelines
Installation of Individual Heating Stations	Emissions during civil works; construction waste generation; noise; air pollution with dust; labor safety.	Local – phase of civil works	Proper construction waste management; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc. .	Management of a contractor engaged in reconstruction of heat pipelines
Impact during operation				
Heat and hot water supply to consumers in Bukhara	Air pollution due to operation of BHs; water consumption and contaminated water discharge; industrial wastes due to maintenance and overhaul of boiling equipment	Continuously – during operation	To reduce air pollution, the project provides for the use of new energy and cost efficient gas-fueled condensation boilers; water consumption and discharge will be reduced through the introduction of a closed heat supply system and construction of individual heating substations in	District heating company

			residential and public buildings; distribution of all wastes accumulated during maintenance works among enterprises specialized in their disposal and storage; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	

3.4.6. Monitoring and supervision plan

In order to ensure efficient implementation of the mitigation measures proposed, including compliance with environmental requirements during the construction stage, a program of monitoring activities will be required (see it below in *table 38*). Inspections of construction sites are among the duties of the district heating authorities' staff and are covered form their budgets. The impact monitoring on water and air quality, noise, etc., will be done by Contractors and periodically by district heating company. Costs for monitoring activities during the Project construction phase should be included in the bill of quantity for proposed civil works.

Table 38. Monitoring plan

Project activity /Mitigation Measure	*Where* *(is the parameter to be monitored?)*	*What* *(is the parameter to be monitored?)*	*How* *(is the parameter to be monitored?)*	*Who* *(is responsible for monitoring?)*	*When* *(define the frequency / or continuous?)*	*Cost/sources of financing*
1	2	3	4	5	6	7
1. Reconstruction of existing boiler – houses (DBHs) / prevention of air pollution; waste management (collection, separation and disposal); ensuring labor safety through training and provided protective closes	Boiler-houses	Emissions/ dust, NOx; SO2; CO	Visual monitoring; Instrumental observations at the site	Contractor; DH company; State Committee for Environmental Protection	Daily for dust; Measurement of pollutants - before commissioning	Contract-based; Budgetary resources
		Waste/Waste weight and type and related expenditures	Data on collected, separated, transported and disposed along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract-based;
		Occupational safety/conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Constructor; District heating company	Monthly and based on the needs	Contract-based; District heating company operational resources
2. Dismantling of local boiler – houses (BHs) prevention of air pollution; waste management (collection, separation and disposal); ensuring labor safety through training and provided protective closes	Equipment room	Emissions/ dust	Visual monitoring;	Contractor; DH company;	Daily	Contract-based; Budgetary resources
		Waste weight and type and related expenditures	Contractor data on collected, separated, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract-based;
		Occupational safety/number of accidents; conducted specialized training, number of participants	Accident register; Training register; Expenditures for	Constructor; District heating company	Monthly and based on the needs	Contract-based; District heating company operational

		and provided protective closes	protective closes			resources
3. Electricity network reconstruction: laying cable lines; installation of transformers in existing transformer substations, and construction of new substations Soil protection; Prevention of air emissions from vehicles and equipment and watering for dust prevention; Noise prevention through calibration of equipment and working during daily time hours; Construction waste management – their collection, separation and disposal; Potential tree loses; Ensuring labor safety.	Electrical cable route& transformer stations	Emissions/smoke from vehicles and working equipment; Dust; Expenditures.	Visual monitoring; Expenditures for watering	Contractor	Daily	Contract-based
		Soil protection/ volume of excavated and/or recultivated soil (m3)	Data on implemented works and on related expenditures	Contractor	Weekly	Contract-based
		Waste/type and weight; associated expenditures	Contractor data on collected, separated, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract-based
		Noise/level of noise in DbA	Instrumental measurements	Contractor; Sanitary inspection	Weekly	Contract based; District heating company resources
		Number of trees cut	Expenditures for tree cut	Contractor; District heating company	Monthly	District heating company resources
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources
4. IHS construction / Prevention of dust and emissions from equipment; Noise prevention; Construction waste management; Ensuring labor safety	Residential buildings	Emissions/dust and equipment emissions	Visual monitoring	Contractor	Once	Contract-based
		Noise/level of noise in DbA	Instrumental measurements	Contractor; Sanitary inspection	Weekly	Contract based; District heating company resources
		Waste/weight	Contractor data on collected, transported and disposed waste along with the data on expenditures for implemented waste	Contractor	Weekly	Contract based; District heating company resources

			management activities			
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources

3.4.7. State Ecological Expertise approval

The EIA&EMP study for HP – Bukhara city has been submitted for its review and approval to the State Committee for Environmental Protection (State Ecological Expertise) and on September 04, 2016 it has been officially approved (Decision No. 18/13963). The SEE decision specifies overall the EA report is of good quality and corresponds to all national environmental requirements. The document also mentions the next EA step should be presenting to the SEE before putting in operation the district heating is the Declaration on environmental impacts along with the all necessary environmental permits and licences (in particular for air emissions, for waste water discharges, waste management). It is also indicated the Bukhara Committee for Environmental protection will keep under control and supervise implementation of all environmebntal requirements, specified in the EMP.

3.5. EIA & EMP for Samarkand city

3.5.1. Current status of city's district heating system and proposed invest

Samarkand is the second after Tashkent by economic value and the third largest city of our Republic. The diverse impact exerted by Samarkand in the productive and economic and social sphere of the republic and the region becomes one of the essential factors in forecasting its long-term development. At the same time Samarkand is a treasury of world culture and preserving its values is the most important objective in planning of its development in the future.

The city is located in the core of the Central area of Uzbekistan, in the junction of historical ways and modern railway, automobile and air networks. Having beneficial economical and geographical location, it developed intensively, being created as the center of the whole region – the Basin of Zarafshan river.

Samarkand plays the leading role in the Republic economy as the diversified industrial center. Here large industrial enterprises of engineering and mechanical, chemical and light industries, as well as the entities of construction materials and structures are located. Number of entities are the only ones in the republic. There is considerable number of joint foreign ventures in the city, such as "UZBAT", "Samkochavto", "Samarkand-Prague", "Samarkand-California", tomato plant "Chele-Baltimore", "Singapore-Samarkand", etc.

The condition of heat supply system in Samarkand city. 37 boiler houses with single established thermal capacity from 0,2 to 91 Gcal/h providing heat supply of multi-storey apartment houses, social and cultural facilities, schools, kindergartens, health care facilities and other consumers are part of OJSC "Samarkand Issiklik manbai".

680 multi-storey apartment houses, some state organizations and other consumers, including colleges, lyceums, schools, kindergartens, social and cultural and health care facilities are connected to the thermal networks of OJSC "Samarkand issiklik manbai" now.

Main objectives to be achieved through reconstruction include the following: (a) create a modern scheme of high-quality uninterrupted and resource efficient heating and select the most appropriate heating options to meet the needs of population, social institutions and other economic entities in heat to ensure comfort temperatures in residential and public buildings; (b) selection of the optimum scheme of heat supply; (c) choosing of efficient and modern equipment for installation on new sources of heat supply and for replacement of the obsolete equipment on the existing sources; (d) introduction of the modern system of control and accounting, production and consumption of heat energy; (e) reconstruction and modernization of the existing boiler houses and thermal networks, construction of new district local boiler houses with carrying out reconstruction and rehabilitation of external and in-house thermal networks for achievement of high-quality heat supply of the population at efficient and reliable operation of the heat supply system.

Long term of operation of the equipment of boiler and thermal networks in Samarkand is the reason for the continuing deterioration of their technical condition, decrease in reliability, increase in heat losses, and, as a result, increase of probability of accidents with possible negative consequences for the environment.

The following is planned within the project "Scheme for Development of Heat Supply of Samarkand City":

1. Installation of two new gas-fired boilers with total capacity of 85 MW, which is sufficient to meet the current heat demand.

2. Replacement of about 25 km (one-pipe length) of DH network.

3. Installation of 346 IHS to serve residential and public buildings connected to the DH system. Substations shall be modern, fully automated, and equipped with heat meters for billing purposes.

4. Electricity network reconstruction. This will include laying cable lines (6 kV and 0.4 kV), and construction of new substations (no old transformers will be replaced).

5. Maintenance tools and vehicles for the Samarkand district heating company. This will include special maintenance vehicles and typical mechanical and electric maintenance equipment.

In addition, re-laying of worn-out thermal networks and pipes of in-house heating systems, replacement of obsolete metering devices for natural gas, tap water, electricity and heat, installation of modern metering devices for heat on the lead-outs of heat sources and lead-ins of consumers is planned.

Implementation of the scheme of heat supply of Samarkand city will allow to increase the reliability and sustainability of providing consumers with heat and hot water, to reduce heat losses in networks, emergency risks at generation and supply of the heat to consumers, fuel consumption at heat and hot water production.

3.5.2. Baseline analysis

Climatic Conditions. The climate of Samarkand, as well as all cities of the plain and foothill part of the Central Asia, has clearly expressed signs of arid climate. Here high temperatures of air and low humidity along with clear sky are typical for the summer period. Spring is short and rainy, winter is little-snow. With unstable snow cover.

According to the long-term observations average annual temperature makes $14,8^0$C, absolute minimum – $15,3^0$, absolutely maximum $+41,4^0$.
The coldest month – January, average monthly temperature + $2,4^0$C, the hottest – July, average monthly temperature $26,8^0$.

According to the long-term observations, average annual amount of atmospheric precipitations is 365 mm, of them more than 85% are liquid rainfall. Daily maximum of rainfall makes 45 mm.

Distribution of the amount of precipitations during the year is extremely uneven, most of them (about 84%) fall during the period from November to April, and about 45% of all precipitations falling per year are only in two spring months (March, April). High temperatures of air during the considerable period of the year cause low values of relative

humidity of air which makes 60-74% in cool time (from October to April), and decreases to 43% in summer.

Surface water and its quality. The largest natural waterway in the considered territory is Zarafshan river originating in 900 km to the West from Samarkand from Zarafshan glacier in the mountain gorge between Turkestan and Zarafshan ridges. In mountains the river flows in the narrow, deeply cut valley. In the downstream several relatively large rivers and number of small waterways flow into it. Downstream the Panjikent the river flows from mountains to the wide valley, its bed splits into branches. Turning to the North-West, the river approaches Samarkand city near which it is split into two branches: northern – Akdarya and southern – Karadarya. The island of about 100 km long and up to 15 km wide in its middle part is formed between them.

Irrigation canals and discharge network of artificial and natural origin have special role in formation of engineering-geological conditions in the area of the surveys.

The largest irrigation waterways are irrigation canals Dargom, Jar, Bagishamal, Shaar and Siab collector.

Ground waters. The intermountain hollow within which the area of Samarkand is located, is, generally, the area of transit and discharge and, to a less extent, the area of partial accumulation of ground waters.

Depending on the conditions of formation and distribution of ground waters, nature of water-containing rocks and other factors, number of water-bearing complexes is identified. 4 water-bearing complexes have the greatest value by quantitative and qualitative indexes, as well as by the extent of the impact on engineering and geological situation in the area of surveys:

1. water-bearing complex in alluvial deposits of middle-quarternary, upper-quarternary and modern period (al QIII, QIII, QIY);
2. water-bearing complex in proluvium deposits of middle-quarternary period (pQ2);
3. water-bearing complex of sporadic distribution in upper-Pliocene deposits (N2 3);
4. water-bearing complex in upper-cretaceous and Palaeocene deposits.

Soil quality. In the area of surveys three types of soils can be identified by their natural features: soils of foothill zone, soils of the III terrace of Zarafshan river and soils of low terraces of Zarafshan river. Soils of the foothill plain are represented by typical and light grey soils and loams. Loessial loams are rock-forming. These soils are characterized by low humus-pressing, strong calcareousness, low content of colloids. Grey soils have fragile microstructure and well expressed microaggregation. In view of considerable biases of the surface, soils are often eroded.

Seismic activity in the city's area is 8 on the Richter scale.

Flora and Fauna. Vegetation in the area of surveys is represented, mainly, by the cultural species typical for oases. Agricultural crops and forest plantings are most widely developed.

Typical representatives of local oasitic vegetation are elm, willows, mulberries, poplar, Asiatic poplar, oleaster, ash-tree, plane tree, walnut and some other. Forest vegetation alternates with garden and field species. Different types and varieties of garden and melon

crops, gardens and vineyards are widely developed. They occupy the considerable part of the territory in suburban zone.

3.5.3. Analysis of project alternatives

The existing system of heat supply of Samarkand city does not provide comfortable conditions for the population in view of strong wear of thermal networks, at the same time losses of heat in the networks average more than 10%.

Thus, the need for increase in volumes of heat supply and at the same time impossibility of use of outdated heating systems and the outdated equipment of the existing boiler houses at full capacity causes the necessity in development of the scheme of heat supply of the city for 2014 - 2020.

One of the perspective directions for the solution of this problem is construction of new local boiler houses, replacement of the outdated and worn-out equipment in the existing boiler houses, replacement of worn-out thermal networks

Project implementation will also allow to solve partially the problem of employment of the population and to create additional job places for servicing of newly-built local boiler houses.

Increase in reliability and sustainability of supply of the consumers with heat and hot water will allow to reduce risks of catarrhal diseases among the population in Samarkand.

In general project implementation within the scheme for development of heat supply system of the city for 2014 - 2020 will allow to raise social and economic living standards of the consumers of heat and hot water produced in new boiler houses in Samarkand that, in turn, will promote development of gender policy in Uzbekistan.

Implementation of the scheme of development of heat supply in Samarkand for 2014 - 2020 will have big social and economic effect for one of the largest regional centers of Uzbekistan.

3.5.4. Impact Assessment

Pollution of surface waters. Sources of negative impact on the condition of surface waters are industrial, household drains, housing estate without sewerage, dumping of energy facilities, pollutants arriving in waterways as result of sloughing from soils after their washing. Lack of the water protection zones along the canals and large aryks has extremely adverse impact on the condition of surface waters, which results in formation of garbage dumps on the coasts of waterways and promotes unauthorized dumping of sewage.

Pollution of soil and ground waters. Pollution of soil during the construction works is possible in case of spills of the oil products used as fuel for movable motor transport and construction equipment. However, pollution will be insignificant and local. Owing to low solubility, oil products will have low migratory capability and won't expose ground waters to danger. Probability of fire as a result of the spills of fuel is also low. In general, during the construction soils and ground waters polluted by oil products will have insignificant risk for the environment and safety of the personnel.

Air pollution. The main sources of pollution of atmospheric air are: industrial and household facilities, motor transport, air transport.

In addition, boiler houses for supply of the city with heat and hot water are located all around the city. Entities, boiler houses emit hazardous substances in the atmosphere of the city: considerable amount of dust of different types (inorganic, cement, salvage, wood, metal, porcelain, cotton, etc.), carbon, nitrogen, sulphur oxides, hydrocarbons, ammonia, phenol, fluoric hydrogen, volatile organic compounds (alcohols, ethers, ketones).

The main polluting hazardous substances in the city are carbon oxide, dust, and volatile organic compounds.

Stress condition of atmospheric air is created along the main highways as a result of emissions of nitrogen oxides. Small dimensions of highways and streets along with high intensity of traffic, insufficient organization of rational traffic, lack of control of emissions of the main ingredients of exhaust gases cause increase in pollution of the atmosphere in the streets of the city.

Atmospheric air will be polluted also by the exhaust gases of mobile motor transport, construction gears at combustion of gasoline and diesel fuel. In addition, welding aerosol, manganese compounds from welding machines at welding works, vapours of organic solvents, aerosol of paints and varnishes will be emitted to the atmospheric air during the painting works.

Impact on vegetation. The main sources of negative impact on vegetation are atmospheric air, soil, ground and surface waters used for irrigation, containing the increased concentration of harmful impurities. Areas with high level of impact on vegetation are correlated with the areas of the increased content of pollutants in the above-listed components and are produced by industrial and energy facilities, as well as highways. In general vegetation condition is satisfactory.

Construction traffic. Impacts from the materials and the equipment used for construction and installation works are the ones at: entrance and departure of heavy machinery, when unloading bulk solids, for example, sand, creation of warehouses, temporary rooms for accommodation and offices, work of internal vehicles and diesel engines, at placement of construction and assembly materials. All materials and equipment, necessary for construction of local boiler houses in Samarkand, will be delivered by cars.

During the modernization of heat supply system and after its termination, certain amount of household wastes and construction debris, including scrap of ferrous metal and wastes of thermal insulation (roofing material and mineral fibre) from dismantling of worn-out thermal networks should be disposed outside the territory of the construction sites.

Noise and vibration. Impact from vibrations is expected: (a) when ramming the piles; (b) when ramming soil; (c) during the work of jackhammers; (d) at consolidation of concrete mixes. Vibrations connected with construction works will have temporary and periodic character, vibration impacts will be within the borders of construction site.

Impact on health and safety. There will be no impact on health of the personnel if safety and health regulations are introduced and observed. Reconstruction and modernization of boiler houses will allow to meet the needs of people in heating and hot water. Operation of the boiler

house of OJSC “Samarkand issiklik manbai” according to the safety and health regulations will not have considerable impact on the environment, but will have positive impact on the social situation of the population.

3.5.5. Environmental Mitigation Plan

Mitigation of environmental impacts will include the following.

Actions for atmospheric emissions purification. After implementation of the scheme for heat supply with construction of new local boiler houses and reconstruction of the existing boiler houses as part of OJSC “Samarkand issiklik manbai”, at combustion of natural gas all boiler houses will emit the following to atmospheric air: nitrogen dioxide, nitrogen oxide, carbon oxide and sulphur dioxide, i.e. 4 pollutants. In total, after the reconstruction of boiler houses in Samarkand and construction of additional local stations, emission of the pollutants to the atmosphere in amount of 334.46 tons/year is expected.

The calculations show that after implementation of the design decision taking into account the recommended actions connected with increase in height of emissions sources, concentration of the pollutants in the atmosphere from emissions of the boiler houses in Samarkand will not exceed the quotas allowed by State Committee for Nature Protection of the Republic of Uzbekistan of 0:25 maximum allowable concentration for substances of the 2nd category of hazard (nitrogen dioxide), 0.33 maximum allowable concentration for substances of the 3rd category of hazard (nitrogen oxide, sulphur dioxide), 0.5 maximum allowable concentration for substances of the 4th category of hazard (carbon oxide).

Actions for protection of water sources. In general, impact on surface waterways during the construction is not expected. However, there is minimum probability of dumping of the excavated material and wastes generated during the construction works to the surface water.

Measures to reduce noise. Noise impacts will occur at three stages:

- At preparation of the foundation and mixing of concrete compound;
- During the installation of steel structures and equipment;
- During the cleaning of the site and commissioning of boiler houses.

Works on cleaning of the site should be relatively silent and noise from putting of the equipment in operation decreases due to antiacoustic actions (coppers of domestic manufacturers have low-noise characteristics according to the provided guarantees).

The equipment should be placed in separate rooms, on vibratory bearings, connection to the systems through flexible inserts. According to the KMK 2.01.08-96 "Protection from noise" the entity won't have significant impact on forming of noise background in the area of placement. It is possible to assume that functioning of the designed facility won't have significant impact on forming of the noise background in the area of its placement.

All the noisiest construction activities, in particular, all works on movement of soil are limited to day time. Therefore, this temporary noise will not have any considerable harmful impact on the housing estate.

Thus, the noise connected with construction activities will have temporary and periodic nature, and will not exceed the noise standards.

Waste management. Production wastes of all local boiler houses of the city are, generally, delivered for utilization to the specialized enterprises: scrap of ferrous metal is delivered for utilization to Vtorchermet, the used luminescent lamps – for utilization to the specialized organizations. The greasy rags are burned in fire chambers of boiler houses. Solid domestic wastes are disposed to the solid waste landfill. To store waste and obsolete fluorescent lamps, the project should provide for a separate room equipped with an exhaust ventilation system which capacity per hour should be at least 10 times higher than the room space. Lamps should be stored in boxes; in addition, each lamp should be stored in an individual package made of corrugated cardboard. As this type of waste belongs to mercury-containing waste, it should be collected, stored, registered and transported in accordance with O'z RH 84.3.10: 2004 "Regulation on Handling Procedures for Mercury-containing Products in the Republic of Uzbekistan" and should be safely disposed with ultimate demercuration.

For efficient collection and storage of rubbish and domestic waste, the project shall provide for a separate site equipped with improved covers and special containers with a capacity enough for a 3-day waste, and control its timely transportation by utility service's special trucks. It shall be strictly prohibited to burn solid waste.

During the construction works construction debris will generate as solid wastes. Construction debris, as well as solid domestic wastes, are supposed to dispose to the solid waste landfill. At replacement of worn-out thermal networks scrap of ferrous metals and wastes of thermal insulation are formed as wastes.

For rational collection and storage of litter and domestic wastes the project should provide for separate site equipped with improved coatings and special containers, total number and amount of which should be not less than the amount of domestic wastes and litter generated within three days, as well as to monitor its timely disposal by the machines of housing and communal services. It is strictly forbidden to burn solid domestic wastes.

Soil protection during earthworks. Series of measures shall be provided to protect and prevent soil from contamination on the project site in accordance with GOST 17.4.3.02-85 "Nature Protection. Soil" and GOST 17.5.3.06-85 "Nature Protection. Land Plots": Traffic should move only along constructed roads that ensures safe traffic environment and does not cause vegetation and soil damages.

During the installation and construction works, at installation of individual boiler houses in Samarkand, the project provides for re-cultivation of the land plots with their bringing to the state suitable for further use.

As part of works on re-cultivation it is supposed to:
- dispose construction debris, remove all temporary devices from the construction area;
- distribute the remained soil for filling and levelling of holes and ruts.

For more minimization of the impact of the soils polluted by oil products on the environment, it is recommended to collect the polluted layers of soil into the special tank with further utilization.

For preservation of the fertile layer, the top layer of soil of 20-30 cm deep is removed manually and moved to 25-50 m and is returned to the previous place after completion of the construction. Disposal of construction debris is provided to the specially allocated places.

Gardening of the territory near the local boiler facility is not provided in view of the possibility of maneuvering of motor transport when carrying out repair works during their operation.

Table 39. Mitigation plan

Process resulting in environmental impact	*Environmental impact features*	*Environmental impact duration Local/continuous*	*Measures to reduce environmental impact*	*Institutional responsibility for controlling implementation of safeguards*
1	2	3	4	5
Impact during reconstruction of the city heat and hot water supply system				
Reconstruction of existing district boiler-houses (DBHs)	Waste accumulated during dismantling of replaced equipment and construction units; air pollution during delivery and transportation of construction materials to the sites, welding works, concrete preparation works, and excavation works; noise as a result of working equipment; insufficient increase in water consumption – for personnel domestic and drinking needs; personal safety issues	Local – phase of construction works	Distribution of all wastes accumulated during dismantling of equipment and construction units among enterprises specialized in their disposal and storage; strict control over the use of motor vehicles and construction equipment in accordance with established standards; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	Management of a contractor engaged in reconstruction of DBH
Dismantling of local boiler-houses (BHs)	Waste accumulated during dismantling of equipment and construction units; air pollution during demolition and removal of equipment and construction units, and welding works during dismantling phase; noise as a result of working equipment; insufficient increase in water consumption – for personnel domestic and drinking needs; labor safety	Local – phase of construction works	Separation of all wastes accumulated during dismantling of equipment and construction units and their shipment to city landfill or to enterprises collecting ferrous wastes;; strict control over the use of motor vehicles and construction equipment in accordance with established standards; maintenance of the reconstructed sites – leveling, planting of greenery; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	Management of a contractor engaged in dismantling of a local BH
Electricity network reconstruction: laying cable lines;	Construction waste generation; noise; air pollution with dust; labor safety; soil damage; possible cutting down of trees; emissions due to welding	Local – phase of construction works	Proper construction waste management; strict control over the use of motor vehicles and construction equipment in accordance with established standards; maintenance of the	Contractor management

installation of transformers in existing transformer substations, and construction of new substations			reconstructed sites – leveling, planting of greenery; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	
Reconstruction of main and distribution heat networks	Emissions during dismantling of old heat networks (welding equipment, motor vehicles); new heat supply networks require trench works and installation of concrete beds – air pollution with fuel combustion products from equipment, dust emission; soil damage; possible cutting down of trees; emissions due to welding works during installation of pipelines; labor safety	Local – phase of construction works	Distribution of all wastes accumulated during dismantling of heat networks among enterprises specialized in their disposal and storage; strict control over the use of motor vehicles and construction equipment in accordance with established standards (during dismantling and construction works); selection of the optimal route for heat networks; involvement of highly qualified specialists to minimize consumption of welding materials; preserving of soil removed during pipeline construction for its further use for leveling.	Management of a contractor engaged in reconstruction of heat pipelines
Instalation of Individual Heating Stations	Emissions during civil works; construction waste generation; noise; air pollution with dust; labor safety.	Local – phase of civil works	Proper construction waste management; labor safety rules; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc. .	Management of a contractor engaged in reconstruction of heat pipelines
Impact during operation				
Heat and hot water supply to	Air pollution due to operation of BHs; water consumption and contaminated water discharge; industrial wastes due	Continuously – during operation	To reduce air pollution, the project provides for the use of new energy and cost efficient gas-	District heating company

consumers in Samarkand	to maintenance and overhaul of boiling equipment		fueled condensation boilers; water consumption and discharge will be reduced through the introduction of a closed heat supply system and construction of individual heating substations in residential and public buildings; distribution of all wastes accumulated during maintenance works among enterprises specialized in their disposal and storage; personnel training on occupational safety and measures towards compliance with occupational safety requirements; providing of workers with uniforms, glasses, gloves, etc.	

3.5.6. Monitoring and supervision plan

In order to ensure efficient implementation of the mitigation measures proposed, including compliance with environmental requirements during the construction stage, a program of monitoring activities will be required (see it below in *table 40*). Inspections of construction sites are among the duties of the district heating authorities' staff and are covered form their budgets. The impact monitoring on water and air quality, noise, etc., will be done by Contractors and periodically by district heating company. Costs for monitoring activities during the Project construction phase should be included in the bill of quantity for proposed civil works.

Table 40. Monitoring plan

Project activity /Mitigation Measure	*Where* *(is the parameter to be monitored?)*	*What* *(is the parameter to be monitored?)*	*How* *(is the parameter to be monitored?)*	*Who* *(is responsible for monitoring?)*	*When* *(define the frequency / or continuous?)*	*Cost/sources of financing*
1	2	3	4	5	6	7
1. Reconstruction of existing boiler – houses (DBHs) / prevention of air pollution; waste management (collection, separation and disposal); ensuring labor safety through training and provided protective closes	Boiler-houses	Emissions/ dust, NOx; SO2; CO	Visual monitoring; Instrumental observations at the site	Contractor; DH company; State Committee for Environmental Protection	Daily for dust; Measurement of pollutants - before commissioning	Contract-based; Budgetary resources
		Waste/Waste weight and type and related expenditures	Data on collected, separated, transported and disposed along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract-based;
		Occupational safety/conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Constructor; District heating company	Monthly and based on the needs	Contract-based; District heating company operational resources
2. Dismantling of local boiler – houses (BHs) prevention of air pollution; waste management (collection, separation and disposal); ensuring labor safety through training and provided protective closes	Equipment room	Emissions/ dust	Visual monitoring;	Contractor; DH company;	Daily	Contract-based; Budgetary resources
		Waste weight and type and related expenditures	Contractor data on collected, separated, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract-based;
		Occupational safety/number of accidents; conducted specialized training, number of participants	Accident register; Training register; Expenditures for	Constructor; District heating company	Monthly and based on the needs	Contract-based; District heating company operational

		and provided protective closes	protective closes			resources
3. Electricity network reconstruction: laying cable lines; installation of transformers in existing transformer substations, and construction of new substations Soil protection; Prevention of air emissions from vehicles and equipment and watering for dust prevention; Noise prevention through calibration of equipment and working during daily time hours; Construction waste management – their collection, separation and disposal; Potential tree loses; Ensuring labor safety.	Cables' route and transformer stations	Emissions/smoke from vehicles and working equipment; Dust; Expenditures.	Visual monitoring; Expenditures for watering	Contractor	Daily	Contract-based
		Soil protection/ volume of excavated and/or recultivated soil (m3)	Data on implemented works and on related expenditures	Contractor	Weekly	Contract-based
		Waste/type and weight; associated expenditures	Contractor data on collected, separated, transported and disposed waste along with the data on expenditures for implemented waste management activities	Contractor	Weekly	Contract-based
		Noise/level of noise in DbA	Instrumental measurements	Contractor; Sanitary inspection	Weekly	Contract based; District heating company resources
		Number of trees cut	Expenditures for tree cut	Contractor; District heating company	Monthly	District heating company resources
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources
4. IHS construction / Prevention of dust and emissions from equipment; Noise prevention; Construction waste management; Ensuring labor safety	Residential buildings	Emissions/dust and equipment emissions	Visual monitoring	Contractor	Once	Contract-based
		Noise/level of noise in DbA	Instrumental measurements	Contractor; Sanitary inspection	Weekly	Contract based; District heating company resources
		Waste/weight	Contractor data on collected, transported and disposed waste along with the data on expenditures for implemented waste	Contractor	Weekly	Contract based; District heating company resources

			management activities			
		Occupational safety/number of accidents; conducted specialized training, number of participants and provided protective closes	Accident register; Training register; Expenditures for protective closes	Contractor; District heating company	Weekly	Contract based; District heating company resources

3.5.7. State Ecological Expertise approval

The EIA&EMP study for implementation of the "Scheme for development of heat supply of Samarkand city for the period of 2014-2020" has been submitted for its review and approval to the State Committee for Environmental Protection (State Ecological Expertise) and on October 26, 2015 it has been officially approved (Decision No. 18/1335з). The SEE decision specifies overall the EA report is of good quality and corresponds to all national environmental requirements. The document also mentions the next EA step should be presenting to the SEE before putting in operation the district heating is the Declaration on environmental impacts along with the all necessary environmental permits and licenses (in particular for air emissions, for waste water discharges, waste management). Resolution of the State Ecological Expertise about the permissibility of the project implementation does not substitute and does not cancel the need of obtaining the relevant permission documents in the established legislative order. It is also indicated the Samarkand Committee for Environmental protection will keep under control and supervise implementation of all environmental requirements, specified in the EMP, as well as will control utilization of production wastes generated during the dismantling of outworn technological equipment.

4. EA IMPLEMENTING ARRANGEMENTS AND INSTITUTIONAL CAPACITY

4.1. Implementing arrangements, EA roles and responsibilities

4.1.1. Overall organization of project implementation, role and responsibilities of Project Coordination Unit. While overall responsibility with regard to project implementation will lie with a central PCU created under the Kommunkhizmat Agency of the Ministry of Housing and Communal Services, the project safeguards issues will be mostly under the participating utility companies of all five participating cities. The central PCU will have an Environmental Safeguards specialist assigned which will provide overall coordination of individual EMPs implementation, reporting to the MoE and to the WB regarding safeguards issues, as well as, will be responsible for integrating safeguards requirements into biding and contracting documents and for relationships with the environmental and national authorities, ensuring an efficient implementation of safeguards documents. The ES will also be responsible in identifying training needs of the participating district heating companies, and analyzing contracts and applications in terms of environmental management and mitigation issues. The ES will be responsible for periodically collecting information on changes and impact of the project activities and for overall coordination and reporting on the EMPs, inspection of environmental compliance at worksites, advising project participants on environmental questions, coordination the overall environmental monitoring at project level.

4.1.2. Major responsibilities of participating district city companies. The PIUs to be created in all five cities would include a safeguards specialist, who would be the existing staff of each utility responsible for Environment, Health and Safety, or, in the case such specialist is not currently in the staff of the utility, - will be hired for this purpose. The main EA scope of these companies is to ensure that the project activities are implemented in full compliance with the WB and national EA rules and procedures as well as with the EMP requirements. Among major responsibilities of the PIU safeguards specialist will be included the following: (a) ensuring that contractors complies with all safeguard and statutory requirements during construction, and specifically the EMPs; (b) coordination of all environmental and EA related issues; (c) conducting EMP supervision and monitoring and assessing the environmental impacts and efficiency of mitigation measures, as well as identifying non-compliance issues or adverse trends in results, and putting in place programs to correct any problems identified; (d) communication with an EIA competent authority (Kommunkhizmat Agency; State Committee for Environmental Protection; Ministry of Economy, municipalities etc.); (e) if needed providing advises and consultation to contractors in EMP implementation; and (f) reporting to the PCU with regard to EMP implementation.

4.1.3. Contractors' responsibilities. The actual investment programs will be carried out by contractors selected through a public tender process. They should operate in full compliance with national environmental legislation and with the EMP requirements. Further, the contractors are obliged to follow regulative requirements of the national law related to traffic safety, occupational health and safety; fire safety; environmental protection; and community health and safety. All EMP associated activities will be financed by the contractors. The contractors will also be requested to designate a person in charge of environmental, health and safety issues and for implementing the EMP.

4.2. Integration of the EMPs into project documents

The EMP provisions will form part of the design documents for the project, and will be included in construction contracts for proposed activities, both into specifications and bills of quantities. Respectively the Contractors will be required to include the cost of EMP requirements in their financial bids and required to comply with them while implementing the project activities. The bidding documents for selecting the contractors will include specifications that would ensure effective implementation of environmental, health and safety performance criteria by the winning bidder and in particular: (i) preventing/limiting disturbance of soils and vegetation removal to the minimum; prevent soil compaction as well as other potential impacts; (ii) ensuring that all ground disturbing activities are conducted consistent with the construction requirements; (iii) developing a traffic management plan that include measures to ensure work zone safety for construction workers and the travelling public; (iv) conducting all activities on installing new boilers will be done with due care, ensuring labor safety; and (iv) the traffic management plan should be approved by the Traffic Police prior to commence of any construction/repair works; etc. The contract with winning bidder will include necessary also an obligation to inform the DH companies of any significant HSE accidents and events among subcontracted project workers.

4.3. Supervision, monitoring reporting and grievance mechanism

4.3.1. Environmental supervision and monitoring. During subproject implementation district heating companies will have overall supervision responsibility for assuring that the measures indicated in the EMP are being properly performed. Independently or in collaboration with the local environmental authorities will perform the subproject environmental monitoring during both construction and operation phases as specified in the monitoring plan of the EMP.

4.3.2. Reporting. Supervision of the EMPs implementation will be the responsibility of the DH enterprises which periodically (as per monitoring schedule) will prepare short reports on EMPs implementation to be submitted to the PCU. PCU will compile these reports and semi-annually will present short information about the EMP implementation as part of the Progress Reports to the WB. Regular subproject progress reports should include a section entitled "Environmental Management". The section should be as brief as possible: providing a condensed description of the monitoring activities, any issues identified and how they were or are planned to be resolved.

4.3.3. Grievance mechanism. In accordance with WB requirements there should be in place a grievance mechanism to respond to complaints related to the implementation of this project and in particular with reard to implementation of EMPs. This mechanism is designed to enable the receipt of complaints of affected people and public concerns regarding the environmental and social performance of the project. Such mechanism should be based on accessible and transparent procedures to receive and resolve complaints. It is anticipated that the majority of issues that might be potentially raised by local population or interested parties will be informational in nature or feedback that requires small course corrections. For that purpose in each participating PIUs the Safeguards Specialists will be also in charge of dealing with all potential compaints, informing about that all parties, by posting on the web contact information and how and when she/he might be reached. In the case of issues that are of higher level, the Safeguards Sepcialists will involve the PCU Safeguards Specialists. His/her coordinates also will be posted on the web. Issues having to do with governance issues—at the client or by World Bank staff—will be addressed at a higher level, either an appeals or

supervisory body within the client or senior management within the Bank, - information about what also will be posted on the web.

4.4. Funding for EMPs implementation

During the (re)construction/implementation phase, the EMPs implementation will be funded by the project beneficiaries. All (re)construction and installation activities will be provided by contracted companies. They are responsible for full and qualitative implementation of the EMPs' provisions. The costs that are related to supervision monitoring and reporting activities to be performed by the PCU and participating district heating companies will be included in their operational costs.

4.5. EA institutional capacity and proposed TA activities

4.5.1. EA institutional analysis. Conducted analysis shows only Tashkent district heating company have in place an Environmental Specialist, while in the case of other companies EA responsibilities are delegated from time to time to other specialists in charge of Chemical Service; Safety and Occupational Hazards divisions; or Technical Supervision divisions. The companies have in place only some elements of the environmental management system mostly in terms safety issues and conduct periodical training for their staff, which includes also some environmental aspects, like waste management and reduction of pollutant emissions. While these companies have implemented up to know several investment projects, financed by the state and municipal budgets, their specialists have not been involved in monitoring and reporting of EMPs implementation. Furthermore, they are not familiar with the requirements of International Financial Institutions (including WB) in this regard. None of these companies have been certified under ISO 1400 (Environmental Management) or under ISO 18000 (Operational Health and Safety Management System).

4.5.2 Proposed capacity building activities and necessary funding. A training program for the PCU, PIUs and for assigned safeguards specialists will be implemented in the framework of the Project's institutional component. It is proposed the PCU environmental safeguards specialist should have training course on EA techniques and procedures. For that purpose, they might visit similar WB projects in other countries in the region and/or to hire a consultant who might provide on the job training. In terms of the participating district companies where there will be a designated safeguards specialist there should be provided training on environmental monitoring, supervision and reporting. Another important aspect of the training should be on ISO 14001 as well as on ISO 18001 that would explain not only their provisions but also practical aspects of certification of district companies under these two standards. The training program should be practical and include work with realistic case studies, covering an explanation and practical application of the environmental standards and forms designed for use by the WB. The training will cover the following issues: (a) national and World Bank requirements for environmental assessment; (b) main provisions of environmental management plans for proposed sub projects, including mitigation and monitoring requirements and roles and responsibilities of the PCU and PIUs in that regard; and (c) relevant ISO environment and safety standards. Field studies also may be included. To implement proposed capacity building activities the project will support hiring a local consulting company or a specialized design institute. Estimated budget for proposed capacity building activities and trainings is presented in the *table 41* below.

Table 41. Estimated budget for capacity building activities

Target Group	*Purpose of Training*	*Number of Workshops/Activities and year of implementation*	*Costs of Workshop/Activity in USD*
District heating company representatives; PCU; PIUs	To ensure that district heating companies, PCU and PIUs safeguards specialists are aware about the project environmental, health and social impacts	1 workshops (YR1)	10,000/workshop
District heating company representatives; PCU; PIUs	To ensure that district heating companies, PCU and PIUs safeguards specialists are aware about the requirements, procedures and certification processes under the ISO 14000 and 18000	1 workshop (YR 2)	10,000 workshop
PCU Safeguards Specialist	To provide PCU safeguards specialist with knowledge on the EIA process; on the integration of EMPs requirements into project documents conducting a study tour to a similar WB project in other country in the region	1 study tour (YR1)	35000/study tour
PIU Safeguards Specialists	Environmental awareness and a practical exercise on environmental management plans for proposed sub projects and on mitigation, monitoring and reporting requirements; on and roles and responsibilities of the PCU and PIUs in ensuring their implementation. Practical aplications in the field.	3 workshops (YR1, YR2 and YR3)	5,000 - (1,000/workshop)
Total: 30,000			

5. EA REPORT DISCLOSURE AND PUBLIC CONSULTATIONS

5.1 EA disclosure and consultations in Andijan.

The draft EIA&EMP was disclosed for all interested parties on January 22, 2015 on the municipality website: www.andijan.uz. From January 23 – 27 the hard copies of the Executive Summary of the draft document has been distributed to the key stakeholders: sanitary and environmental authorities, design institutes, environmental NGOs and mahalas. On February, 14, 2015, the PIU has organized a public consultation, which was well attended by all interested partiesn (altogether more that 50 representatives from various institutions and local population – mahalas have attended the meeting). The meeting concluded the document is very well prepared, covers all important impacts and necessary mitigation and monitoring activities and fully corresponds to the national environmental requirements. All details on the consultation including the minutes, list of participants and their signatures along with a series of pictures are kept in the project files.

5.2 EA disclosure and consultations in Bukhara

The draft EIA&EMP was disclosed for all interested parties on the Bukhara regional municipality website: www.buxoro.uz and also it was published in newspaper "Bukhoronoma" dated October 08, 2016 for No. 82. On October 17, 2016 the PIU has organized a public consultation in office building of JSC Bukharaenergomarkaz, which was well attended by all interested partiesn (altogether more that 38 representatives from various institutions and local population – mahalas have attended the meeting). The meeting concluded the document is very well prepared, covers all important impacts and necessary mitigation and monitoring activities and fully corresponds to the national environmental requirements. All details on the consultation including the minutes, list of participants and their signatures along with a series of pictures are kept in the project files.

5.3 EA disclosure and consultations in Chirchik

Similarly, the draft EIA&EMP was disclosed for all interested parties on March 16, 2015 on the municipality website: chirchiq.toshvil.uz. On April 3, 2015, the municipal district heating company “Issiklik Energiasi” has organized a public consultation, which was well attended by all interested parties (altogether about 30 representatives from various institutions and local population – mahalas have attended the meeting). The meeting concluded the document is very well prepared, covers all important impacts and necessary mitigation and monitoring activities and fully corresponds to the national environmental requirements. All details on the consultation including the minutes, list of participants and their signatures along with a series of pictures are kept in the project files.

5.1. EA disclosure and consultations in Samarkand

The draft EIA&EMP was disclosed for all interested parties on the Samarkand regional municipality website: www.samarkand.uz and also it was published in newspaper "Samarkandskiy vestnik" dated October 08, 2016. On October 17, 2016 the PIU has organized a public consultation in medical college of Samarkand city, which was well attended by all interested partiesn (altogether more that 22 representatives from various institutions and local population – mahalas have attended the meeting). The meeting was

organized in coordination with the local authorities of all project rayons. Participants were provided with handovers presentation slides on EIA&EMP. Project consultant briefly described project overview, principles and methods adopted for EIA&EMP and environmental features of the project area, possible environmental impacts of the project, and proposed mitigation measures against the negative environmental externalities were distributed as a handout and discussed point by point. After the presentation, participants were invited to to share their views and opinions, and deliver their questions and comments. All details on the consultation including the minutes, list of participants and their signatures along with a series of pictures are kept in the project files.

5.2. EA disclosure and consultations in Sergili district of Tashkent city

The draft EIA&EMP for Sergeli district was disclosed for all interested parties on May 20, 2015 on the municipality district heating company website: www.toshissiqquvvati.uz. Furthermore, the draft document was submitted to key stakeholders: Tashkent city council; Sergeli district council; Tashkent city Public Utility Company; State Ecological Expertise of Tashkent Committee for Environmental Protection; Central Sanitary-Epidiemiological Committee of Tashkent city as well as to “Uztyajneftegaschemproekt” design Institutte. On June 3, 2015, the city district heating company “Toshissiqquvvati” in the conference hall of the district Khokimiyat has organized a public consultation, with the participation of more than 150 people, - representatives from different interested parties. The largest group of participants were from House Owners Associations, Communal and Repair organizations, makhalla representatives and different agencies related to the Project. The meeting concluded the document is very well prepared, covers all important impacts and necessary mitigation and monitoring activities and fully corresponds to the national environmental requirements. All details on the consultation including the minutes, list of participants and their signatures along with a series of pictures are kept in the project files.

Annex 1: Air emissions from district heating company in Andijan city

Production facility, shop, site	*Emission source*	*Natural gas consumption, mln cubic/year*	*Emission source operating hours hours/year*	*# of the source on the map*	*Height of emission source, m*	*Chimney's diameter*	*Parameters of gas-and-air mixture*			*Pollutant*	*Pollutant emissions*		
							Volume, cubic m/sec	*Speed, m/sec*	*Temperature (^0C)*		*g/sec (max)*	*mg/m^3 (max)*	*t/year*
1	2	3	4	5	6	7	8	9	10	11	12	13	14
"Shimoliy" DBH-1	Gas condensing boiler Heat load 36.58 Gcal/hr	17.892	3648	1	45	0.7	5.3878	14.0	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.0601 12.471 5.039	11.2 2314.7 935.3	0.801 163.783 45.714
DBH-2	Gas condensing boiler Heat load 33.46 Gcal/hr	16.259	3648	2	45	0.7	5.3878	14.0	80	Sulfur dioxide Carbon ,monoxide Nitrogen dioxide	0.0553 11.333 3.163	10.3 2103.4 587.1	0.726 148.835 41.542
Local Boiler-house for Microdistrict 3	Gas condensing boiler Heat load 18.42 Gcal/hr	9.062	3648	3	25	0.5 5	1.7106	7.2	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.0308 6.316 1.736	18.0 3692.3 1030.6	0.405 82.953 23.153
Local Boiler-house for Microdistrict 4	Gas condensing boiler Heat load 10.36 Gcal/hr	5.0968	3648	4	25	0.5 5	1.7106	7.2	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.0174 3.553 0.991	10.2 2077.1 579.3	0.228 46.6580 13.023

Local Boiler-house for Microdistrict 5	Gas condensing boiler Heat load 8.83 Gcal/hr	4.344	3648	5	25	0.5 5	1.7106	7.2	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.0148 3.33 0.845	8.7 1946.7 494.0	0.194 43.741 11.1
Local Boiler-house for Microdistrict 6 (Kvartal (residential quarter) 125)	Gas condensing boiler Heat load 4.75 Gcal/hr	2.337	3648	6	25	0.5 5	1.7106	7.2	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.008 1.63 0.455	4.7 952.9 266.0	0.1045 21.4 5.97
Local Boiler-house 7 (Microdistrict between Navoi St., Aliendo St., and Fitrat St.)	Gas condensing boiler Heat load 4.29 Gcal/hr	2.1424	3648	7	25	0.5 5	1.7106	7.2	80	Sulfur dioxide Carbonmon oxide Nitrogen dioxide	0.0073 1.49 0.416	4.3 871.0 243.2	0.0958 19.61 5.47
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	12	13	14
Local Boiler-house 8 (“Medgorodok” Microdistrict)	Gas condensing boiler Heat load 4.59 Gcal/hr	2.2904	3648	8	25	0.5 5	1.7106	7.2	80	Sulfur dioxide Carbon moinoxide Nitrogen dioxide	0.0078 1.59 0.445	4.6 929.5 260.1	0.1025 20.962 5.85
Local Boiler-house 9 (“Buston” Microdistrict).	Gas condensing boiler Heat load 7.6 Gcal/hr	3.7704	3648	9	25	0.5 5	1.7106	7.2	80	Sulfur dioxide Carbonmon oxide Nitrogen dioxide	0.0129 2.628 0.733	7.5 1536.3 428.5	0.169 34.51 9.632
Mini BH-10 A. Temur Av. (Motor vehicle park)	Mini boiler-house of a container type Heat load 1.26 Gcal/hr	0.599	3648	10	10	0.2 5	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.002 0.417 0.116	11.0 2296.0 638.7	0.0268 5.4832 1.53
Mini BH-11 Ashurov St., Usupov St.	Mini boiler-house of a container type Heat load 0.18 Gcal/hr	0.0857	3648	11	10	0.2 5	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.0003 0.06 0.017	1.7 330.4 93.6	0.0038 0.785 0.219
Mini BH-12	Mini boiler-house of	0.3658	3648	12	10	0.2	0.1816	3.7	80	Sulfur dioxide	0.00125	6.9	0.0164

Temir Yul	a container type Heat load 0.77 Gcal/hr					5				Carbon monoxide Nitrogen dioxide	0.255 0.071	1404.0 390.9	3.349 0.935
Mini BH-13 Bukhara St.	Mini boiler-house of a container type Heat load 0.56 Gcal/hr	0.2663	3648	13	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbonmon oxide Nitrogen dioxide	0.00091 0.255 0.0518	5.0 1404.0 285.2	0.0119 3.349 0.68
Mini BH-14 Ogahiy St.	Mini boiler-house of a container type Heat load 0.52 Gcal/hr	0.248	3648	14	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00084 0.173 0.0483	4.6 952.5 265.9	0.0111 2.271 0.63
Mini BH-15 Babur Av. – Oltinkul St.	Mini boiler-house of a container type Heat load 0.64 Gcal/hr	0.3042	3648	15	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbonmon oxide Nitrogen dioxide	0.00104 0.212 0.06	5.7 1167.3 330.4	0.0136 2.785 0.777
Mini BH-16 Babur Av. – Uzbekistan Av.	Mini boiler-house of a container type Heat load 0.15 Gcal/hr	0.07114	3648	16	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.000242 0.05 0.014	1.3 275.3 77.1	0.0032 0.651 0.1817
Mini BH-17 Universitet St.	Mini boiler-house of a container type Heat load 0.46 Gcal/hr	0.2188	3648	17	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.000745 0.152 0.042	4.1 836.9 231.2	0.0098 2.004 0.559
Mini BH-18 Ashurov St.	Mini boiler-house of a container type Heat load 0.90 Gcal/hr	0.4279	3648	18	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00146 0.298 0.083	8.0 1640.8 457.0	0.0191 3.917 1.093
Mini BH-19 Nizomiy St.	Mini boiler-house of a container type Heat load 0.56 Gcal/hr	0.2663	3648	19	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00091 0.255 0.0518	5.0 1404.0 285.2	0.0119 3.349 0.68

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mini BH-20 Puppet theatre	Mini boiler-house of a container type Heat load 0.08 Gcal/hr	0.03794	3648	20	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00013 0.0264 0.0074	0.7 145.4 40.7	0.0017 0.347 0.0969
Mini BH-21 Murabbiylar St.	Mini boiler-house of a container type Heat load 0.36 Gcal/hr	0.1711	3648	21	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00058 0.119 0.0333	3.2 655.2 183.3	0.0077 1.566 0.437
Mini BH-22 A. Temur Av. – Babur Av.	Mini boiler-house of a container type Heat load 0.42 Gcal/hr	0.19954	3648	22	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00068 0.139 0.039	3.7 765.3 214.7	0.0089 1.826 0.5090
Mini BH-23 A. Temur Av. – Babur Av.	Mini boiler-house of a container type Heat load 0.10 Gcal/hr	0.04742	3648	23	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00016 0.033 0.0092	0.9 181.7 50.7	0.0021 0.434 0.121
Mini BH-24 Babur Av. – Sanoat St.	Mini boiler-house of a container type Heat load 0.05 Gcal/hr	0.02371	3648	24	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00008 0.0165 0.0046	0.4 90.8 25.3	0.0011 0.217 0.0606
Mini BH-25 Sarvontepa	Mini boiler-house of a container type Heat load 0.46 Gcal/hr	0.2188	3648	25	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.000745 0.152 0.042	4.1 836.9 231.2	0.0098 2.004 0.559
Mini BH-26 Chulpon St.	Mini boiler-house of a container type Heat load 0.90 Gcal/hr.	0.2809	3648	26	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00096 0.196 0.055	5.3 1079.2 302.8	0.0126 2.571 0.718
Mini BH-27 Chulpon St.	Mini boiler-house of a container type	0.4093	3648	27	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon	0.00139 0.285	7.7 1569.2	0.0183 3.747

	Heat load 0.86 Gcal/hr									monoxide Nitrogen dioxide	0.08	440.5	1.046
Mini BH-28 Chulpon St.	Mini boiler-house of a container type Heat load 1.0 Gcal/hr	0.47424	3648	28	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.0016 0.33 0.092	8.8 1816.9 506.5	0.0212 4.341 1.212
Mini BH-29 Navoi Av.	Mini boiler-house of a container type Heat load 0.65 Gcal/hr	0.31008	3648	29	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00105 0.216 0.06	5.8 1189.3 330.4	0.0139 2.838 0.792
Mini BH-30 Chulpon St.	Mini boiler-house of a container type Heat load 1.03 Gcal/hr	0.4888	3648	30	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00165 0.34 0.095	9.1 1872.0 523.1	0.0218 4.474 1.249
Mini BH-31 Chulpon St.	Mini boiler-house of a container type Heat load 0.51 Gcal/hr	0.24186	3648	31	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00082 0.168 0.047	4.5 925.0 258.8	0.0108 2.214 0.618
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mini BH-32 Chulpon St.	Mini boiler-house of a container type Heat load 0.86 Gcal/hr	0.40857	3648	32	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00133 0.285 0.079	7.3 1569.2 435.0	0.0175 3.74 1.044
Mini BH-33 Ashurov St.	Mini boiler-house of a container type Heat load 0.51 Gcal/hr	0.24077	3648	33	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00082 0.168 0.047	4.5 925.0 258.8	0.0108 2.204 0.615
Mini BH-34 Navoi Av. – Oltinkul St.	Mini boiler-house of a container type Heat load 0.55 Gcal/hr	0.2663	3648	34	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00091 0.255 0.0518	5.0 1404.0 285.2	0.0119 3.349 0.68

Mini BH-35 Navoi Av.	Mini boiler-house of a container type Heat load 0.08 Gcal/hr	0.03794	3648	35	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00013 0.0264 0.0074	0.7 145.4 40.7	0.0017 0.347 0.0969
Mini BH-36 Istiklol St.	Mini boiler-house of a container type Heat load 0.34 Gcal/hr	0.1616	3648	36	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00055 0.113 0.0314	3.0 622.2 172.9	0.0072 1.479 0.413
Mini BH-37 Navoi Av. – Chulpon St.	Mini boiler-house of a container type Heat load 0.31 Gcal/hr	0.1616	3648	37	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00055 0.113 0.0314	3.0 622.2 172.9	0.0072 1.479 0.413
Mini BH-38 Babur Av.	Mini boiler-house of a container type Heat load 0.61 Gcal/hr	0.3042	3648	38	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00104 0.212 0.06	5.7 1167.3 330.4	0.0136 2.785 0.777
Mini BH-39 DSK	Mini boiler-house of a container type Heat load 0.83 Gcal/hr	0.39398	3648	39	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00134 0.275 0.0077	7.4 1514.1 42.5	0.0176 3.606 0.101
Mini BH-40 AskiUsh St.	Mini boiler-house of a container type Heat load 0.19 Gcal/hr	0.0857	3648	40	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.0003 0.06 0.017	1.7 330.4 93.6	0.0038 0.785 0.219
Mini BH-41 Aliendo St. – Khidiraliev St.	Mini boiler-house of a container type Heat load 0.72 Gcal/hr	0.3658	3648	41	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00125 0.255 0.071	6.9 1404.0 390.9	0.0164 3.349 0.935
Mini BH-42 Babur Av.	Mini boiler-house of a container type	0.07114	3648	42	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon	0.000242 0.05	1.3 275.3	0.0032 0.651

	Heat load 0.16 Gcal/hr									monoxide Nitrogen dioxide	0.014	77.1	0.1817
Mini BH-43 Sanoat St.	Mini boiler-house of a container type Heat load 0.74 Gcal/hr	0.35167	3648	43	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.0012 0.245 0.0684	6.6 1348.9 376.6	0.0157 3.219 0.898
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mini BH-44 Babur Av. – Mirpustin St.	Mini boiler-house of a container type Heat load 1.45 Gcal/hr	0.6884	3648	44	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.0023 0.48 0.134	12.7 2642.8 737.8	0.0307 6.302 1.759
Mini BH-45 DukchiEshon Microdistrict	Mini boiler-house of a container type Heat load 0.8 Gcal/hr	0.3794	3648	45	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.0013 0.264 0.074	7.2 1453.6 407.4	0.017 3.473 0.969
Mini BH-46 DukchiEshon Microdistrict	Mini boiler-house of a container type Heat load 1.49 Gcal/hr	0.7095	3648	46	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.0024 0.49 0.138	13.2 2697.9 759.8	0.0317 6.495 1.813
Mini BH-47 Navoi Av.	Mini boiler-house of a container type Heat load 0.11 Gcal/hr	0.05217	3648	47	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00018 0.036 0.01	1.0 198.2 55.1	0.0023 0.477 0.133
Mini BH-48 DukchiEshon Microdistrict	Mini boiler-house of a container type Heat load 0.91 Gcal/hr	0.4279	3648	48	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00146 0.298 0.083	8.0 1640.8 457.0	0.0191 3.917 1.093
Mini BH-49 DukchiEshon Microdistrict	Mini boiler-house of a container type Heat load 0.34 Gcal/hr	0.1616	3648	49	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00055 0.113 0.0314	3.0 622.2 172.9	0.0072 1.479 0.413

Mini BH-50 Tashkent St.	Mini boiler-house of a container type Heat load 1.33 Gcal/hr	0.6311	3648	50	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00205 0.44 0.123	11.3 2422.6 677.2	0.0269 5.777 1.612
Mini BH-51 Nizomiy St.	Mini boiler-house of a container type Heat load 0.82 Gcal/hr	0.39398	3648	51	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00134 0.275 0.077	7.4 1514.1 42.4	0.0176 3.606 0.101
Mini BH-52 Babur Av.	Mini boiler-house of a container type Heat load 0.36 Gcal/hr	0.1616	3648	52	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00055 0.113 0.0314	3.0 622.2 172.9	0.0072 1.479 0.413
Mini BH-53 Babur Av.	Mini boiler-house of a container type Heat load 0.21 Gcal/hr	0.10214	3648	53	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00035 0.0712 0.02	1.9 392.0 110.1	0.0046 0.935 0.261
Mini BH-54 Babur Av – Shimoliy Microdistrict	Mini boiler-house of a container type Heat load 0.22 Gcal/hr	0.10214	3648	54	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00035 0.0712 0.02	1.9 392.0 110.1	0.0046 0.935 0.261
Mini BH-55 Babur Av – Shimoliy Microdistrict	Mini boiler-house of a container type Heat load 0.25 Gcal/hr	0.12367	3648	55	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00042 0.0862 0.024	2.3 474.6 132.1	0.0055 1.132 0.316
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mini BH-56 Babur Av - Shimoliy Microdistrict	Mini boiler-house of a container type Heat load 0.34 Gcal/hr	0.1616	3648	56	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00055 0.113 0.0314	3.0 622.2 172.9	0.0072 1.479 0.413
Mini BH-57	Mini boiler-house of	0.2188	3648	57	10	0.2	0.1816	3.7	80	Sulfur dioxide	0.000745	4.1	0.0098

Babur Av - Shimoliy Microdistrict	a container type Heat load 0.45 Gcal/hr					5				Carbon monoxide Nitrogen dioxide	0.152 0.042	836.9 231.2	2.004 0.559
Mini BH-58 Shevchenko St. – Lermontov St.	Mini boiler-house of a container type Heat load 0.97 Gcal/hr	0.45965	3648	58	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.0015 0.32 0.042	8.3 1761.9 231.2	0.0196 4.207 0.559
Mini BH-59 Babur Av.	Mini boiler-house of a container type Heat load 0.34 Gcal/hr	0.1616	3648	59	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00055 0.113 0.0314	3.0 622.2 172.9	0.0072 1.479 0.413
Mini BH-60 Babur Av.	Mini boiler-house of a container type Heat load 0.7 Gcal/hr	0.3658	3648	60	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00125 0.255 0.071	6.9 1404.0 390.9	0.0164 3.349 0.935
Mini BH-61 Babur Av.	Mini boiler-house of a container type Heat load 0.26 Gcal/hr	0.12367	3648	61	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00042 0.0862 0.024	2.3 474.6 132.1	0.0055 1.132 0.316
Mini BH-62 Fitrat St.	Mini boiler-house of a container type Heat load 0.38 Gcal/hr	0.1616	3648	62	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00055 0.113 0.0324	3.0 622.2 172.9	0.0072 1.479 0.413
Mini BH-63 Fitrat St.	Mini boiler-house of a container type Heat load 0.36 Gcal/hr	0.1616	3648	63	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00055 0.113 0.0314	3.0 622.2 172.9	0.0072 1.479 0.413
Mini BH-64 Fitrat St.	Mini boiler-house of a container type Heat load 1.13 Gcal/hr	0.4888	3648	64	10	0.25	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00165 0.34 0.095	9.1 1872.0 523.1	0.0218 4.474 1.249

Mini BH-65 Navoi Av.	Mini boiler-house of a container type Heat load 0.21 Gcal/hr	0.10214	3648	65	10	0.2 5	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.00035 0.0712 0.02	1.9 392.0 110.1	0.0046 0.935 0.261
Mini BH-66 Navoi Av.	Mini boiler-house of a container type Heat load 1.22 Gcal/hr	0.599	3648	66	10	0.2 5	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.002 0.417 0.116	11.0 2296.0 638.1	0.0268 5.4832 1.53
Mini BH-67 Navoi Av.	Mini boiler-house of a container type Heat load 0.87 Gcal/hr	0.40857	3648	67	10	0.2 5	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.0175 0.285 0.079	96.4 1569.2 435.0	0.0013 3.74 1.044
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mini BH-68 Khidiraliev St. – Sanoat St.	Mini boiler-house of a container type Heat load 0.19 Gcal/hr	0.0857	3648	68	10	0.2 5	0.1816	3.7	80	Sulfur dioxide Carbon monoxide Nitrogen dioxide	0.0003 0.06 0.017	1.7 330.4 93.6	0.0038 0.785 0.219