Initial Environmental Examination

Project Number: 51418-001
September 2018

Proposed Loan for People's Republic of China: Air Quality Improvement in the Greater Beijing–Tianjin–Hebei Region — Shandong Clean Heating and Cooling Project (West Jinan Waste Heat Utilization and Clean Energy Component)

Prepared by Jinan Thermal Power Co., Ltd. for the Asian Development Bank

CURRENCY EQUIVALENTS

(as of 12 September 2018)

Currency Unit	–	Chinese Yuan (CNY)
CNY1.00	=	€ 0.1258
€1.00	=	CNY 7.9482

ABBREVIATIONS

ADB	Asian Development Bank
AP	Affected Person
AQI	Air Quality Index
CHP	Combined heat and power
EA	Executing Agency
EHS	Environment, Health and Safety
EIA	Environmental Impact Assessment
EMoP	Environmental Monitoring Plan
EMP	Environmental Management Plan
EMS	Environmental Monitoring Station
EPB	Environmental Protection Bureau
EPL	Environmental Protection Law
FSR	Feasibility Study Report
FGD	Flue-gas Desulfurization
GDP	Gross Domestic Product
GHG	Green House Gas
GIP	Good International Practice
GIIP	Good International Industrial Practice
GRM	Grievance Redress Mechanism
HSP	Heat source plant
IA	Implementing Agency
IEE	Initial Environmental Examination
IT	Interim Target
JHG	Jinan Heating Group
JTPC	Jinan Thermal Power Co,. Ltd
MAC	Maximum Acceptable Concentration
MEE	Ministry of Ecology and Environment
MEP	Ministry of Environmental Protection
MSDS	Material Safety Data Sheet
PAM	Project Administration Manual
PCR	Physical Cultural Resources
PPE	Personnel Protective Equipment
PPTA	Project Preparatory Technical Assistance

PRC	People's Republic of China
SPG	Shandong Provincial Government
SPS	Safeguard Policy Statement, ADB
TA	Technical Assistance
WB	World Bank
WHO	World Health Organization
WWTP	Wastewater treatment plant

WEIGHTS AND MEASURES

BOD_5	Biochemical Oxygen Demand, five days
$CaCO_3$	Calcium Carbonate
cm	Centimeter
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
dB(A)	A-weighted sound pressure level in decibels
DO	Dissolved Oxygen
kg	Kilogram
km	Kilometer
kWh	Kilowatt Hour
Leq	Equivalent Continuous Noise Level
m	Meter
m/s	Meters per Second
m^2	Square Meters
m^3	Cubic Meters
mg/l	Milligrams per Liter
mg/m^3	Milligrams per Cubic Meter
$\mu g/m^3$	Micrograms per Cubic Meter
NO_x	Nitrogen Oxides
^oC	Degrees Celsius
O_3	Ozone
pH	A measure of the acidity or alkalinity of a solution
PM	Particulate Matter
PM_{10}	Particulate Matter smaller than 10 micrometers
$PM_{2.5}$	Particulate Matter smaller than 2.5 micrometers
RT	Refrigerating Ton
SO_2	Sulfur Dioxide
t/h	Tons per Hour
TSP	Total Suspended Particulates

NOTES

(i) In this report, "$" refers to US dollars and "€" refers to Euro.

(ii) This document has been prepared following ADB's Safeguard Policy Statement 2009.

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EXECUTIVE SUMMARY

A. Introduction

1. This Initial Environmental Examination (IEE) report has been prepared for the proposed West Jinan Waste Heat Utilization and Clean Energy Component of the Shandong Clean Heating and Cooling Project (the Project) in Shandong Province of the People's Republic of China (PRC). The proposed Project is the fourth in a multi-year multi-sectoral Asian Development Bank (ADB) support for air quality improvement in the greater Beijing–Tianjin–Hebei (BTH) region.

2. This component will: (i) install district heating network in west Jinan utilizing industrial waste heat as the main heat source to reduce coal use with a district heating of 80 million m^2. The industrial waste heat is from Xinyuan Power Plant (6×600MW water-cooling gen-sets) and Haoji Power Plant (4×360MW water-cooling gen-sets) and transferred through long-distance pipelines to transmit hot water recovered from the waste heat; (ii) provide district heating to 29 communities which are not connected to the district heating pipeline network by gas-driven heat pumps, gas-fired boilers and air source heat pumps. The total heating area is 2.5697 million m^2. The component will reduce coal combustion for urban heating, contributing to better air quality in Jinan City.

B. Policy, Legal and Administrative Framework for Environmental Impact Assessment

3. Environmental impact assessment (EIA) procedures have been established in the PRC for over 20 years. Domestic EIA studies are required to be undertaken by relevant PRC environmental laws and regulations. National and local legal and institutional frameworks for EIA review and approval ensure that proposed projects are environmentally sound, designed to operate in line with applicable regulatory requirements, and are not likely to cause significant environment, health, social, or safety hazards.

4. ADB's Safeguard Policy Statement (SPS) 2009 has also been carefully considered. All applicable requirements of the SPS 2009 have been addressed in the IEE.

C. Implementation Arrangements

5. Shandong Provincial Government (SPG) will be the executing agency (EA) and responsible for overall guidance during project preparation and implementation. Jinan Thermal Power Co., Ltd. (JTPC), a state-owned company will be the implementing agency (IA) and responsible for implementing the component and administering and monitoring contractors and suppliers. A project management office (PMO) by the Jinan Municipal Bureau of Housing and Urban-rural Development will be responsible for day-to-day management of the Project.

D. Project scope

6. The component scope includes: (i) 1x1.5MW, 1x3.5MW, 4x2.8MW, 2x10.5MW and 3x7MW gas fired boilers to provide heating to an area of 1,030,000 m^2; (ii) 40 air source heat pump units to provide heating to an area of 50,200 m^2; (iii) 1,311 gas-driven heat pump units to provide heating to an area of 1,489,500 m^2 and (iv) 93.568 km of primary district heating network to provide district heating to 80 million m^2 in west Jinan by industrial waste heat; Once completed, the component will provide district heating to an area of 82,569,700 m^2.

E. Construction Schedule

7. The total construction period for the Project will be approximately 5 years from 2018 t0 2022.

F. Description of the Environment

Location and Topography

8. The component is located in west urban area of Jinan City, Shandong Province. Jinan City, with a total area of 10,356 km^2, is located in the northwest of the north shore of the Yellow River, bordering Hebei Province in north. It is located at east longitude 115°45'- 117°36' and northern latitude 36°24 '- 38°00'. Dezhou City is in south and Binzhou City is in east of Jinan City.

9. Jinan City occupies a transition zone between the northern foothills of the Taishan Massif to the south-southeast and the Yellow River Valley to the north and northwest. Karst aquifers in limestone formations sloping down from the south to the north give rise to many artesian springs in the city center as well as in surrounding areas. Within the component area the topography is generally flat.

Meteorology and Climate

10. Jinan has a temperate continental climate with four distinct seasons. It is dry in the spring, hot and rainy in the summer, cool in the autumn, and dry and cold in the winter. The average annual temperature in Jinan is 16.6°C; the average summer average temperature is 26°C and the maximum recorded summer temperature was 42.7°C. The average temperature in the coldest months of winter is below 0°C, and the extreme lowest recorded temperature is -19.5°C. The annual average precipitation in Jinan from 1950-2011 was 685 mm and 65.9% of the precipitation occurs in June, July and August.

Water Resources

11. Annual average surface water resource of Jinan City is 1,158 million m^3, underground freshwater resources is 958 million m^3. The population of Jinan is 7.23 million and per capita water resource is only 292 m^3.

Ecological and Sensitive Resources

12. The component site is located in west urban area of Jinan City. Surrounding land uses include mixed commercial and residential areas with little or no vegetation cover. There are no known rare or endangered flora or fauna, parks, nature reserves or areas with special national, regional or local ecological significance within or adjacent to the component site.

Socioeconomic Conditions

13. Jinan is the political, economic, cultural, scientific, educational, and financial center of Shandong province, and has been designated with sub-provincial administrative status since 1994.

14. In 2017, Jinan's GDP was CNY 720.196 billion, of which the primary sector (agriculture) accounted for 4.4% or CNY 31.740 billion; the secondary sector (industries) accounted for 35.7%

or CNY 256.922 billion; and the tertiary (services) sector accounted for 59.9% or CNY 431.534 billion.

Physical Cultural Resources

15. Jinan is an accredited famous historic and cultural city for its long-standing history and culture. Historic sites include Chengziya Longshan Culture Site, Guo's Ancestral Temple of Han Dynasty at Xiaotangshan, Four Gates Pagoda of Sui Dynasty, Dragon and Tiger Pagoda of Tang Dynasty, Nine Tops Tower and Luozhuang Han Tomb.

16. Jinan has a rich history. However, the component activities are all within the Jinan urban area. There are no known physical cultural resources (PCRs) in the component site.

G. Anticipated Impacts and Mitigation Measures

17. Anticipated positive and negative environmental impacts of the proposed component were assessed based on the domestic Feasibility Study Report (FSR), domestic EIA report, a technical due diligence review of the component undertaken by ADB PPTA specialists; public consultations led by IA and assisted by ADB PPTA consultants; and site visits, surveys and consultations undertaken by ADB PPTA consultants.

18. Pre-construction, construction and operation phases were considered separately. The results of the assessment indicate that during the pre-construction phase environmental issues are very limited and are mostly associated with ensuring appropriate incorporation of mitigation measures into the project design.

19. Potential negative environmental impacts during construction phase are short-term and localized, and are associated with soil erosion, construction noise, fugitive dust, solid waste, wastewater, disruption of traffic and community services, and risks to workers and community health and safety. These can be effectively mitigated through good construction and health and safety practices.

20. Potential negative impacts during operation phase are associated with air pollutants emission, solid waste, wastewater, noise, and health and safety risks to workers and community. These can be effectively mitigated through good operation of the facility equipment, including air pollution control equipment, and health and safety practices.

21. Potential positive operation phase impacts are significant and long-term and are associated with emissions reductions compared to equivalent heat through traditional coal-fired sources. Once operational the component will: (i) result in annual energy savings equivalent to 1,157,368.0 tons of coal equivalent (tce), thereby providing a global public good by avoiding the annual emission of 3,054,491.8 tons of CO_2; (ii) improve local air quality through the estimated annual reduction of emissions of SO_2 by 3,649.5 tons, NOx by 3,638.1 tons, and PM by 609.8 tons; and (iii) eliminate the negative impacts of coal transportation through urban areas by truck or train.

H. Alternative Analysis

22. The district heating area in Jinan increased from 87.6 million m^2 in 2012 to 147 million m^2 in 2017. With rapid urban expansion heat demand increases dramatically, leading to an urgent need to construct new heating infrastructure. For the 29 communities which will get district heating

from the component, if the component is not implemented, heat from traditional coal-fired heat source plants (HSPs) will be required to meet the increasing demand for district heating of the 29 communities. Existing polluting coal-fired boilers will continue to be used. Based on an overall analysis of alternatives, the component has selected the most appropriate heat sources, heating technique and pipeline type with installation method.

23. Implementation of the component will: (i) improve energy consumption structure; (ii) significantly reduce coal consumption; (iii) improve air quality; and (iv) reduce greenhouse gas (GHG) emissions.

I. Information Disclosure and Public Consultations

24. Domestic EIA Institute has undertaken one round of public consultation and two rounds of information disclosure in accordance with the Interim Guidelines on Public Consultation for EIA (2006) during domestic EIA process.

25. According to ADB SPS's requirements, the JTPC held five separate public consultation meeting from March – April 2018 during the preparation of the IEE. A public project information notice was posted in the nearby communities for two weeks prior to the meeting. Five public consultation meetings were held in No. 17 community, and meeting rooms of Lashan HSP, Jinjiling HSP, Minghu HSP and Nanjiao HSP.121 nearby residents were invited to the meeting. During the meeting, information on the component construction content and status was presented by the JHG, while information on potential environmental impacts and proposed mitigation measures, GRM requirements of ADB and component benefits was presented by social consultant and environmental consultant. Then questions and subsequent discussions focused on environmental issues of the component and benefits of the component especially clean district heating and employment promotion. During the meetings, most of the participants believed that the component can provide a clean district heating service and provide more job opportunities to the nearby communities and 100% of participants supported the construction of component.

26. During the social survey, the same questionnaires were also distributed. In the social survey, 82 were distributed and 82 completed questionnaires were received.

27. Most of the respondents work and live within a 5 km radius of the component; 53.7% of respondents knew about project either from other person, newspapers or information signs, and 91.1% of respondents indicated that they were already familiar with the project benefits after the introduction of the project. The top three environment issues respondents identified in their neighborhoods are air quality (66.5%), noise (41.9%) and surface water (17.7%). Dust and noise were identified as the top two issues during the construction phase. Air pollution and noise were identified as the top two issues during the operation phase. However, most participants also indicated that potential air, waste water, solid waste and noise impacts can be appropriately mitigated.

28. Overall support for the project is very strong; 83.7% of the respondents indicated that the project will improve local economic development; 92.6% indicated that the project will improve quality of life; and 93.6% of respondents indicated that they support the proposed project.

29. Meaningful consultation will continue throughout detailed design, construction, and operation phases, including information disclosure by the project proponent and posting of project information on community notice boards.

J. Grievance Redress Mechanism

30. A component-level grievance redress mechanism (GRM) has been established to receive and facilitate resolution of complaints during the construction and operation phases. The GRM includes procedures for receiving grievances, recording/documenting key information, and evaluating and responding to the complainants in a reasonable timeframe. Any concerns raised through the GRM will be addressed quickly and transparently, and without retribution to the affected persons.

K. Environmental Management Plan (EMP)

31. A comprehensive EMP has been developed to ensure: (i) implementation of identified mitigation and management measures to avoid, reduce, mitigate, and compensate for anticipated adverse environment impacts; (ii) implementation of monitoring and reporting against the performance indicators; and (iii) compliance with the PRC's relevant environmental laws, standards and regulations and the ADB's SPS 2009. The EMP includes an environment monitoring plan (EMoP) to monitor the environmental impacts of the component and assess the effectiveness of mitigation measures, and a capacity building and training program focused on health, safety and environment. Organizational responsibilities and budgets are clearly identified for implementation, monitoring and reporting. The EMP is presented in Appendix I.

L. Risks and Key Assurances

32. The IA has limited experience in ADB's projects. To support effective implementation of the project EMP, (i) a full-time Environment and Social Officer will be appointed in the PMO; (ii) a part-time loan implementation environmental consultant (LIEC) will be recruited to support the PMO; (iii) pre-construction readiness monitoring and defined roles and responsibilities of all relevant agencies have been included in the EMP; and (iv) staff will receive training on ADB's environment safeguard requirements and EMP implementation.

M. Conclusion

33. Through the environmental assessment process, it is concluded that the component has: (i) selected appropriate technologies to improve energy structure and reduce the emission of pollutants; (ii) identified potential negative environment impacts and established mitigation measures; (iii) received public support from the component beneficiaries and affected people; (iv) established project-level GRM procedures; and (v) prepared a comprehensive EMP including environmental management and supervision structure, environmental mitigation and monitoring plans, and capacity building and training.

34. Overall, any minimal adverse environmental impacts associated with the component can be prevented, reduced, or minimized through the appropriate application of mitigation measures. It is therefore recommended that: (i) the component is classified as environment category B; and (ii) the component will be supported by ADB, subject to the implementation of the commitments contained in the EMP and allocation of appropriate technical, financial and human resources by the borrower to ensure these commitments are effectively and expediently implemented.

I. INTRODUCTION

A. The Project

1. This IEE report has been prepared for the proposed West Jinan Waste Heat Utilization and Clean Energy Component of the Shandong Clean Heating and Cooling Project (the Project) in Shandong Province of the PRC. The proposed Project is the fourth in a multi-year multi-sectoral ADB support for air quality improvement in the greater BTH region.

2. This component will: (i) install district heating network in west Jinan utilizing industrial waste heat as the main heat source to reduce coal use with a district heating of 80 million m^2. The industrial waste heat is from Xinyuan Power Plant (6×600MW water-cooling gen-sets) and Haoji Power Plant (4×360MW water-cooling gen-sets) and transferred through long-distance pipelines to transmit hot water recovered from the waste heat; (ii) provide district heating to 29 communities which are not connected to the district heating pipeline network by gas-driven heat pump, gas-fired boilers and air source heat pumps. The total heating area is 2.5697 million m^2. The component will reduce coal combustion for urban heating, contributing to better air quality in Jinan City.

3. The component will be implemented through three outputs:

i) **Output 1**: Provide district heating to 29 communities which are not connected to the district heating pipeline network by gas-driven heat pumps, gas-fired boilers and air source heat pumps. Total heating area of the component will be 2,569,700 m^2.

ii) **Output 2**: 93.568 km of primary district heating pipeline network will be constructed to provide district heating to 80 million m^2 in west Jinan by industrial waste heat. The pipe networks will utilize two-pipe system. One is water supply pipe and another is water return pipe; and

iii) **Output 3**: Strengthened capacity to install and maintain clean heating technologies.

4. The component scope includes: (i) 1x1.5MW, 1x3.5MW, 4x2.8MW, 2x10.5MW and 3x7MW gas fired boilers to provide heating to an area of 1,030,000 m^2; (ii) 40 air source heat pump units to provide heating to an area of 50,200 m^2; (iii) 1,311 gas-driven heat pump units to provide heating to an area of 1,489,500 m^2, and (iv) 93.568 km of primary district heating network to provide district heating to 80 million m^2 in west Jinan by industrial waste heat. Once completed, the component will provide district heating to an area of 82,569,700 m^2.

B. Introduction of Borrower

5. Shandong Provincial Government (SPG) will be the executing agency (EA) and responsible for overall guidance during project preparation and implementation. Jinan Thermal Power Co., Ltd. (JTPC), a state-owned company will be the implementing agency (IA) and responsible for implementing project components and administering and monitoring contractors and suppliers. A project management office (PMO) led by the Jinan Municipal Public Utilities Bureau,

involving Shandong Provincial Department of Housing and Urban-rural Development, Department of Finance, PDRC, Jinan Municipal DRC, Jinan Municipal Bureau of Finance will be responsible for day-to-day management of the project.

6. JTPC was founded in March 2008 and its main businesses are district heating and power, steam and hot water supply. JTPC is responsible for district heating supply in urban area and western part in Jinan City. JTPC is the largest district heating company with biggest heating area in Shandong Province.

7. JTPC has a registered capital of 950 million CNY and total assets of 6.721 billion CNY. Operating income in 2017 was 1.504 billion CNY. JTPC has 12 departments and 8 sub-companies. At the end of 2017, JTPC has 2,137 employees including 733 professional and technical personnel. Now JTPC has 12 sets of generator units with a total installed capacity of 166.5 MW, 16 sets of steam boilers with a total capacity of 1,355 tons per hour, 72 sets of hot water boilers with a total capacity of 2,311 MW, 2 main steam pipes and 22 main hot water pipes with a total heating pipe network length of 1,060 km.

C. Report Purpose

8. ADB's environmental safeguard requirements are specified in the SPS 2009. The component has been screened and classified as Environment Category B, requiring the preparation of an IEE (this report) including an EMP. The EMP is presented in **Appendix I**.

D. Approach to report Preparation

9. This report has been prepared based on a domestic Feasibility Study Report (FSR); domestic EIA report; a technical due diligence review of the FSR undertaken by ADB project preparatory technical assistance (PPTA) consultants; public consultations with key stakeholders and affected persons attended by PPTA consultants; and site visits, surveys, consultations undertaken by ADB PPTA environmental consultants and ADB mission discussions with the IA and relevant government agencies.

E. Report Structure

10. This IEE report consists of an executive summary, nine chapters and one appendix. The report is structured as follows:

Executive Summary
Summarizes critical facts, significant findings, and recommended actions.

I Introduction
Introduces the proposed component, report purpose, approach to EIA preparation and EIA structure.

II Policy, Legal, and Administrative Framework
Discusses PRC's and ADB's environmental assessment legal and institutional frameworks, status of approval of the domestic EIA reports, and applicable environmental guidelines and standards.

III Description of the Project
Describes the project rationale, scope, components, location, key features, implementation arrangements, budget and time schedule.

IV Description of the Environment
Describes relevant physical, biological, and socioeconomic conditions within the component area.

V Anticipated Environmental Impacts and Mitigation Measures
Describes impacts predicted to occur as a result of the component and identifies the mitigation measures which will be implemented.

VI Analysis of Alternatives
Presents an analysis of alternatives undertaken to determine the best way of achieving the component objectives while minimizing environmental and social impacts.

VII Information Disclosure, Consultation, and Participation
Describes the process undertaken for engaging stakeholders and carrying out information disclosure and public consultation.

VIII Grievance Redress Mechanism
Describes the component grievance redress mechanism (GRM) for resolving complaints.

IX Conclusion and Recommendation
Presents conclusions drawn from the assessment and recommendations.

Appendix

11. Appendix I presents the EMP, including required construction and operation phase environmental mitigation measures, EMoP, reporting requirements, and capacity building. Other appendices present supporting documentation and approvals, due diligence of associated facilities, and coal and emission reduction factors and calculations.

Figure I-1: Jinan City, Shandong Province.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

12. This IEE has been prepared in accordance with both the PRC's national and local environmental legal and institutional framework and environmental assessment requirements, and applicable ADB policies, requirements and procedures.

A. Applicable ADB Policies, Regulations and Requirements

13. The major applicable ADB policies, regulations, requirements and procedures for EIA are the *Safeguard Policy Statement* (SPS, 2009) and the *Environmental Safeguards – A Good Practice Sourcebook* (2012), which jointly provides the basis for this IEE. The SPS promotes good international practice as reflected in internationally recognized standards such as the World Bank Group's Environment, Health and Safety (EHS) Guidelines.

14. The SPS establishes an environmental review process to ensure that projects undertaken as part of programs funded through ADB loans are environmentally sound, are designed to operate in line with applicable regulatory requirements, and are not likely to cause significant environment, health, social, or safety hazards.

15. At an early stage in the project cycle, typically the project identification stage, ADB screens and categorizes proposed projects based on the significance of potential project impacts and risks. A project's environment category is determined by the category of its most environmentally sensitive component, including direct, indirect, induced, and cumulative impacts. Project screening and categorization are undertaken to:

i) reflect the significance of the project's potential environmental impacts;

ii) identify the type and level of environmental assessment and institutional resources required for the safeguard measures proportionate to the nature, scale, magnitude and sensitivity of the proposed project's potential impacts; and,

iii) determine consultation and disclosure requirements.

16. ADB assigns a proposed project to one of the following categories:

i) **Category A.** Proposed project is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented; impacts may affect an area larger than the sites or facilities subject to physical works. A full EIA including an EMP is required.

ii) **Category B**. Proposed project's potential environmental impacts are less adverse and fewer in number than those of category A projects; impacts are site-specific, few if any of them are irreversible, and impacts can be readily addressed through mitigation measures. An initial environmental examination (IEE), including an EMP, is required.

iii) **Category C**. Proposed project is likely to have minimal or no adverse environmental impacts. No EIA or IEE is required although environmental implications need to be reviewed.

iv) **Category FI**. Proposed project involves the investment of ADB funds to, or through, a financial intermediary.

17. The component has been classified as environment category B and thus an IEE is required.

18. The SPS 2009 requires a number of additional considerations, including: (i) project risk and respective mitigation measures and project assurances; (ii) project-level grievance redress mechanism; (iii) definition of the project area of influence; (iv) physical cultural resources damage prevention analysis; (v) climate change mitigation; (vi) occupational and community health and safety requirements (including emergency preparedness and response); (vii) economic displacement that is not part of land acquisition; (viii) biodiversity conservation and natural resources management requirements; (ix) provision of sufficient justification if local standards are used; (x) assurance of adequate consultation and participation; and (xi) assurance that the EMP includes an implementation schedule and measurable performance indicators. These requirements, which may not be covered in the domestic EIA, have been considered, and all applicable environmental requirements in the SPS 2009 are covered in this IEE.

19. During the design, construction, and operation phases of a project, the SPS also requires the borrower to follow environmental standards consistent with good international practice (GIP), as reflected in internationally recognized standards such as the World Bank Group's *EHS Guidelines*.[1] The *EHS Guideline*s contain discharge effluent, air emissions, and other numerical guidelines and performance indicators as well as prevention and control approaches that are normally acceptable to ADB and are generally considered to be achievable at reasonable costs by existing technology. When host country regulations differ from these levels and measures, the borrower is to achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, the borrower is required to provide justification for any proposed alternatives.

B. PRC Environmental Legal Framework

20. The environmental protection and management system in the PRC consists of a well-defined hierarchy of regulatory, administrative and technical institutions. At the top level the People's Congress of the PRC has the authority to pass and revise national environmental laws; the Ministry of Ecology and Environment (MEE, former Ministry of Environmental Protection) under the State Council promulgates national environmental regulations; and the MEE either separately or jointly with the Administration of Quality Supervision, Inspection and Quarantine issues national environmental standards. Provincial and local governments can also issue provincial and local environmental regulations and guidelines in accordance with the national ones. In addition, national and local five-year environmental protection plans form an important part of the legal framework.

21. Key applicable PRC environmental laws are listed in **Table II-1** including associated regulations and decrees that support their implementation. Guidelines for EIA implementation are

1 The guidelines applied for this component are Environmental, Health, and Safety General Guidelines, Environmental, Health, and Safety Guidelines for Construction and Decommissioning. These guidelines can be found at http://www.ifc.org/ehsguidelines

listed in **Table II-2**.

22. The most far-reaching law on pollution prevention and control is the Environmental Protection Law (EPL) (1989, amended 2014, effective 2015 and item 2 in **Table II-1**), which sets out key principles for the country's pollution control system, including the policy known as the "Three Simultaneities Policy" [2], the application of pollution levies, and requirements for EIA. The implementation of the "Three Simultaneities Policy" was further strengthened by decrees on its implementation (items 28 and 30) and the Construction Project Environmental Protection Management Regulation (item 19).

23. The amended EPL further defines enforcement and supervision responsibilities for all levels of environmental protection authorities, imposes stricter obligations and more severe penalties on enterprises and construction units regarding pollution prevention and control, and allows for environmental public interest litigation including through nongovernment organizations. The procedures and requirements for the technical review of EIA reports by authorities have been specified (**Table II-1** item 4), and environmental inspection and enforcement on design, installation, and operation of project-specific environmental protection and control measures are regulated under the "Three Simultaneities Policy" (**Table II-1** items 5, 15, 25, 26, and 28).

24. Public participation and environmental information disclosure provisions are among the most significant changes introduced in the amended EPL, further supported by the decrees on the preparation of EIA summaries for public disclosure (item 26), information disclosure on construction project EIAs by government (item 24), method for public participation in environmental protection (item 22), and technical guidelines for public participation in EIAs.

25. For grievance redress, a hotline number (12369) was established in March 2011 at each level of environmental protection authority throughout the country for receiving and resolving environmental complaints, in accordance with the Management Measures for Operation of the Environmental Complaint Hotline (MEP Decree 2010 No. 15 [item 29]).

26. The PRC also provides protection for community health and occupational health and safety through the Labor Law (1994) (item 13), the Occupational Disease Prevention and Control Law (2001) (item 5), PRC Safety Production Law (item 4), State Administrative Regulations of Safety Production (item 18) and environmental and hygiene standards for construction sites.

Table II-1: Applicable PRC Environmental Laws, Regulations, and Decrees

No.	Laws	Year Issued/Updated
1	National Environmental Impact Assessment Law	2016
2	Environmental Protection Law	2015
3	Atmospheric Pollution Prevention and Control Law	2015
4	Safety Production Law	2014
5	Occupational Disease Prevention and Control Law	2011

2 The "Three Simultaneities Policy" requires the design, construction, and operation of pollution control and treatment facilities to occur simultaneously with the project design, construction, and operation.

6	Water and Soil Conservation Law	2011
7	Water Pollution Prevention and Control Law	2010
8	Urban and Rural Planning Law	2008
9	Solid Waste Pollution Prevention and Control Law	2005
10	Water Law	2002
11	Cultural Relics Protection Law	2002
12	Noise Pollution Prevention and Control Law	1999
13	Labor Law	1995
	Regulations	
14	Atmospheric Pollution Prevention and Control Action Plan (State Council Announcement No. 37)	2013
15	Policy on Integrated Techniques for Air Pollution Prevention and Control of Small Particulates (MEP Announcement No. 59)	2013
16	Planning Environmental Impact Assessment Regulation	2009
17	Cultural Relics Protection Law Implementation Regulation	2003
18	State Administrative Regulations of Safety Production	2003
19	Construction Project Environmental Protection Management Regulation	1998
20	Wild Plant Protection Regulation	1996
	Decrees and Announcements	
21	Directory for the Management of Construction Project EIA Categorization (MEP Decree 2017-44)	2017
22	Measures for Public Participation in Environmental Protection (MEP Decree 2015-35)	2015
23	Management Measures for Environmental Impact Post Assessment of Construction Projects (on trial) (MEP Decree 2015-37)	2015
24	Government Information Disclosure of Construction Project EIA (on trial) (MEP Announcement No. 103)	2013
25	Measures for Environmental Supervision (MEP Decree 2012-21)	2012
26	Requirement for Preparation of EIA Report Summary (MEP Announcement 2012-51)	2012
27	Strengthening of EIA Management for Prevention of Environmental Risk (MEP Announcement 2012-77)	2012
28	Opinion from the State Council on Important Tasks for Strengthening Environmental Protection (State Council Announcement 2011-35)	2011
29	Management Measures for Operation of the Environmental Complaint Hotline (MEP Decree 2010-15)	2010
30	Management Procedures for the Supervision, Inspection and Environmental Acceptance of Construction Projects under the “Three Simultaneities” (on trial) (MEP Announcement 2009-150)	2009

31	Specifications on the Management of Urban Construction and Demolition Waste (Ministry of Construction Decree 2005-139)	2005
32	Management Measures for Inspection and Acceptance of Environmental Protection at Construction Project Completion (MEP Decree 2001-13)	2001

Source: ADB PPTA consultants.

C. PRC Environmental Impact Assessment Framework and Procedures

27. **EIA administrative framework.** The administrative framework for EIA in the PRC consists of national, provincial, and local (city and county) environmental protection authorities. The national authority is the MEE, which promulgates laws, regulations, administrative decrees, technical guidelines, and environmental quality and emission standards on EIA and pollution prevention and control. At the provincial level, there are environmental protection departments (EPDs), which act as gatekeepers for EIA and pollution prevention and control in the provinces. They are often delegated authority by the MEE to review and approve EIA reports for development planning and construction projects, except for those projects with national interest and those that cross provincial boundaries. The local (city or county level) environmental protection bureaus (EPB) enforce environmental laws and conduct environmental monitoring within city or county limits. Local EPBs can also be delegated the authority to approve EIA reports by the provincial EPDs. EPDs and EPBs are supported by environmental monitoring stations (EMS), which are subsidiaries of EPDs or EPBs and are qualified entities to carry out environmental monitoring.

28. The former MEP's "Guideline on Jurisdictional Division of Review and Approval of EIAs for Construction Projects" (2009) defines which construction project EIAs require former MEP review and approval, and which EIAs are delegated to the provincial EPDs.

29. The PRC has a qualification and registration system for EIA and only qualified and registered institutes and individuals are allowed to prepare EIAs. Under MEP Decree 2015-36, as of 1 November 2015 qualified institutes for conducting EIAs for construction projects in the PRC can no longer be a subsidiary of an environmental authority responsible for approving EIAs.

30. **EIA legal framework**. EIA is governed by the Environmental Impact Assessment Law (2016) (**Table II-1** item 1), covering EIAs for (i) plans (such as new development areas and new industrial parks) and strategic environmental assessments (SEA), and (ii) construction projects. This was followed by the promulgation of two regulations: the Construction Project Environmental Protection Management Regulation (1998) (item 19) and the Planning Environmental Impact Assessment Regulation (2009) (item 16), both of which require early screening and environmental categorization.

31. **EIA procedures.** EIA procedures have been established in the PRC for over 20 years. In 2008, former MEP issued "Management Guideline on EIA Categories of Construction Projects" (revised 2017). Under MEE decree, Directory for the Management of Construction Project Environmental Impact Assessment Categorization (MEP Decree 2017-44) (item 21) provides detailed EIA requirements for 50 sectors and 192 subsectors and classifies EIAs for construction projects into three categories with different reporting requirements based on the "significance" of potential environmental impact due to the project and the environmental sensitivity[3] of the project

3 Environmentally-sensitive areas are defined in the Decree, and include (i) nature reserves and protected areas, scenic areas, world cultural and natural heritage sites, drinking water source protection zones; (ii) basic farmland and grassland, forest parks, geological parks, important wetland, natural woodland, critical habitats for endangered plant and animal species, important aquatic spawning/nursery/wintering/migration grounds, regions suffering from water resource shortage, serious soil erosion areas, desertification protection areas, eutrophic water bodies; and

site as described in the directory. The directory provides detailed EIA requirements for 50 sectors and 192 subsectors:

(i) **Category A:** projects with significant adverse environmental impacts, for which a full EIA report is required;

(ii) **Category B:** projects with adverse environmental impacts which are of a lesser degree and/or significance than those of Category A, for which a simplified tabular EIA report is required; and

(iii) **Category C:** projects unlikely to have adverse environmental impacts, for which an EIA registration form is required.

32. A full EIA report for category A and a simplified tabular EIA report for category B are similar to ADB's EIA and IEE reports, respectively. The registration form of an EIA is similar to an ADB Category C project.

33. **EIA follow-up actions.** In 2015, the MEP issued decree Management Measures for Environmental Impact Post Assessment of Construction Projects (MEP Decree 2015-37, item 23 of **Table II-1**). Under this decree, a trial program was implemented on 1 January 2016 requiring follow-up actions 3 to 5 years after commencement of project operation for large infrastructure and industrial projects or projects located in environmentally-sensitive areas. These actions include environmental monitoring and impact assessment to verify the effectiveness of environmental protection measures and to undertake any corrective actions that might be needed. The decree also specifies that the institute that did the original impact assessment for the project cannot undertake environmental impact post-assessment for the same project.

34. **EIA guidelines.** The MEE has issued a series of technical guidelines for preparing EIAs (**Table II-2**). These include impact assessment guidelines on general EIA implementation and principles, atmospheric environment and ambient air quality, noise, surface water, groundwater, ecology and regional biodiversity, biodiversity monitoring, quality management on environmental monitoring, and public participation.

Table II-2: Applicable PRC EIA guidelines

No.	Guideline	Date
1	HJ 192-2015 Technical Criterion for Ecosystem Status Evaluation	2015
2	HJ 130-2014 Technical Guidelines for Planning EIA - General Principles	2014
3	HJ 663-2013 Technical Regulation for Ambient Air Quality Assessment (on trial)	2013
4	HJ 2.1-2011 Technical Guidelines for EIA – General Program	2011
5	HJ 19-2011 Technical Guidelines for EIA – Ecological Impact	2011
6	HJ 616-2011 Guidelines for Technical Review of EIA on Construction Projects	2011
7	HJ 623-2011 Standard for the Assessment of Regional Biodiversity	2011

(iii) inhabited areas with major residential, health care, scientific research, and administration functions, cultural heritage protection sites, and protection areas with historical, cultural, scientific, and ethnic values.

8	HJ 630-2011 Technical Guideline on Environmental Monitoring Quality Management	2011
9	Technical Guidelines for EIA - Public Participation (public comment version), (Jan. 2011)	2011
10	HJ 610-2011 Technical Guidelines for EIA – Groundwater Environment	2011
11	HJ 2.4-2009 Technical Guidelines for EIA – Acoustic Environment	2009
12	HJ 2.2-2018 Technical Guidelines for EIA – Atmospheric Environment	2018
13	HJ/T 393-2007 Technical Specifications for Urban Fugitive Dust Pollution	2007
14	JG/J 146-2004 Environmental and Hygiene Standards for Construction Sites	2004
15	HJ/T 2.3-1993 Technical Guidelines for EIA – Surface Water Environment	1993

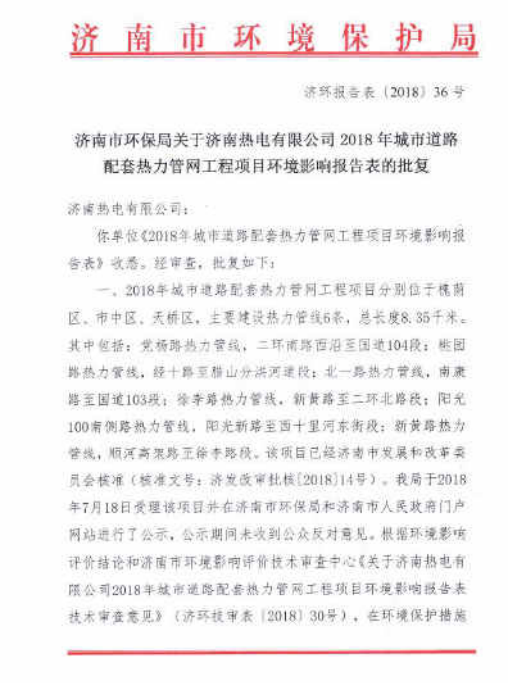
Source: ADB PPTA consultants.

D. Project Domestic EIA Report

35. Under MEE Decree on Management Guideline on EIA Categories of Construction Projects (MEP Decree 2017-44), the component requires 30 separate tabular EIA reports for the 29 communities and pipeline installation. The domestic EIA report for the districting heating pipeline network was prepared by Shandong Environmental Protection Group. The company is certified by the MEE to undertake category A, B, and C assessments.

36. The domestic EIA report for the districting heating pipeline network was disclosed on by Jinan EPB's website from July 18, 2018 to July 28, 2018 (the link is http://jnepb.jinan.gov.cn/art/2018/7/18/art_10432_2130692.html). After the public disclosure, the domestic EIA report was formally approved by Jinan EPB on August 13, 2018. The EIA approval is presented in **Figure II-1**.

Figure II-1: Domestic EIA approval.



济南市环境保护局

济环报告表〔2018〕36号

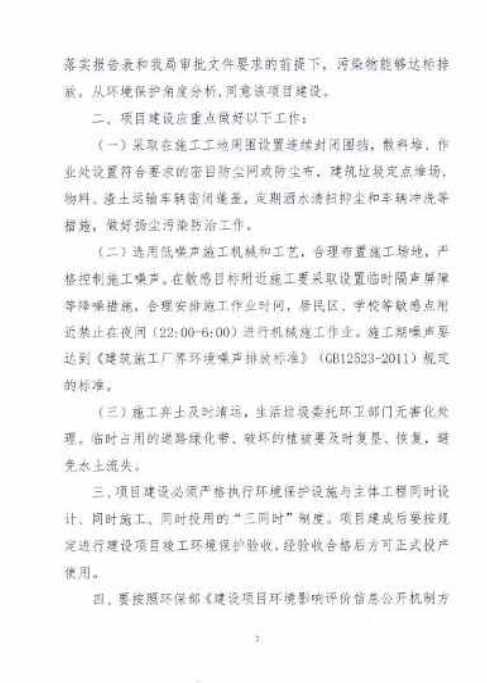
济南市环保局关于济南热电有限公司2018年城市道路配套热力管网工程项目环境影响报告表的批复

济南热电有限公司：

你单位《2018年城市道路配套热力管网工程项目环境影响报告表》收悉。经审查，批复如下：

一、2018年城市道路配套热力管网工程项目分别位于槐荫区、市中区、天桥区，主要建设热力管线6条，总长度8.35千米。其中包括：党杨路热力管线，二环南路西沿至国道104段；槐园路热力管线，经十路至腊山分洪河建段；北一路热力管线，南康路至国道103段；徐李路热力管线，新黄路至二环北路段；阳光100南侧路热力管线，阳光新路至四十里河东街段；新黄路热力管线，顺河高架路至徐李路段。该项目已经济南市发展和改革委员会核准（核准文号：济发改审批核〔2018〕14号）。我局于2018年7月18日受理该项目并在济南市环保局和济南市人民政府门户网站进行了公示，公示期间未收到公众反对意见。根据环境影响评价结论和济南市环境影响评价技术审查中心《关于济南热电有限公司2018年城市道路配套热力管网工程项目环境影响报告表技术审查意见》（济环技审表〔2018〕30号），在环境保护措施

Page 1



落实报告表和我局审批文件要求的前提下，污染物能够达标排放。从环境保护角度分析，同意该项目建设。

二、项目建设应重点做好以下工作：

（一）采取在施工工地周围设置连续封闭围挡，散料堆、作业处设置符合要求的密目防尘网或防尘布，建筑垃圾定点堆场，物料、渣土运输车辆密闭覆盖，定期洒水清扫抑尘和车辆冲洗等措施，做好扬尘污染防治工作。

（二）选用低噪声施工机械和工艺，合理布置施工场地，严格控制施工噪声。在敏感目标附近施工要采取设置临时隔声屏障等降噪措施，合理安排施工作业时间，居民区、学校等敏感点附近禁止在夜间（22:00-6:00）进行机械施工作业。施工期噪声要达到《建筑施工厂界环境噪声排放标准》（GB12523-2011）规定的标准。

（三）施工弃土及时清运，生活垃圾委托环卫部门无害化处理。临时占用的道路绿化带、破坏的植被要及时复垦、恢复，避免水土流失。

三、项目建设必须严格执行环境保护设施与主体工程同时设计、同时施工、同时投用的“三同时”制度。项目建成后要按规定进行建设项目竣工环境保护验收，经验收合格后方可正式投产使用。

四、要按照环保部《建设项目环境影响评价信息公开机制方

案》的有关要求，公开项目建设前、施工过程中和建设后环评信息。

五、各县区环保局要加强对辖区内该建设项目的日常监督检查，市环境监察支队做好监督抽查工作。

2018年8月13日

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37. Because 29 separate communities which will get district heating service from the component are located at Lixia District, Shizhong Distinct, Huaiyin District and Tianqiao District,

29 separate EIAs will be approved by local EPBs where the communities are located based on Jinan EPB's requirements. Equipment installation in 29 communities will be started from 2019, thus at the time of this IEE preparation, all the EIAs are not under preparation. JTHC will prepare domestic separate EIAs and submit them to local EPBs before the equipment installation in each community is started.

E. Relevant International Agreements

38. The PRC has signed a number of international agreements regarding environmental and biological protection. Those which have potential application to the component are listed in **Table II-3.**

Table II-3: Applicable international agreements

No.	Agreement	Year	Purpose
1	Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat	1975	Preventing the progressive encroachment on and loss of wetlands for now and the future
2	Convention Concerning the Protection of the World Cultural and Natural Heritage	1986	Conserving cultural and natural heritage sites.
3	Convention on Biological Diversity	1993	Conservation and sustainable use of biodiversity.
4	UN Framework Convention on Climate Change	1994	Stabilizing greenhouse gas (GHG) concentrations in the atmosphere at a level that will prevent anthropogenic induced climate change.
5	United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification	1996	Fighting against desertification and mitigating the effects of drought.
6	Kyoto Protocol	2002	Controlling emissions of anthropogenic GHGs in ways that reflect underlying national differences in GHG emissions, wealth, and capacity to make the reductions.
7	Stockholm Convention on Persistent Organic Pollutants	2004	Safeguarding human health and the environment from persistent organic pollutants (POPs), ascertaining sound management of stockpiles and wastes that contain POPs, and taking measures to reduce or eradicate releases from intentional production and use of POPs.
8	Paris climate agreement	2015	Dealing with greenhouse gas emissions mitigation, adaptation and finance starting in the year 2020.
9	Minamata Convention on Mercury	2017	A global treaty to protect human health and the environment from the adverse effects of mercury.

Source: ADB PPTA consultants.

F. Applicable PRC Environmental Standards

39. **PRC environmental standards**. Standards issued by the MEE generally consist of environmental quality (ambient) standards applicable to the receiving environment and emission standards applicable to the pollution source. The former includes standards for ambient air quality, noise and vibration, surface water, groundwater, soil, etc. The latter includes standards for integrated wastewater discharge, construction and community noise, odor and air pollutants, etc. (**Table II-4**).

Table II-4: Applicable PRC environmental standards

No.	Standard	Code/Date
1	Ambient Air Quality Standards	GB 3095-2012
2	Quality Standards for Ground Water	GB/T 14848-2017
3	Environmental Quality Standards for Surface Water	GB 3838-2002
4	Environmental Quality Standards for Noise	GB 3096-2008
5	Environmental Quality Standards for Soil	GB 15618-1995
6	Noise Standards for Construction Site Boundary	GB 12523-2011
7	Noise Standards for Industrial Enterprises at Site Boundary	GB 12348-2008
8	Emission standards for Odor Pollutants	GB 14554-93
9	Air Pollutant Integrated Emission Standards	GB 16297-1996
10	Integrated Wastewater Discharge Standards	GB 8978-1996
11	Emission Standard for Community Noise	GB 22337-2008
12	Standard of Environmental Vibration in Urban Area	GB 10070-88
13	Technical Specifications for Regionalizing Environmental Noise Function	GB/T 15190-2014
14	Standard for Flood Control	GB 50210-94
15	Limits and Measurement Methods for Crankcase Pollutants from Heavy-duty Vehicles Equipped with Pressure Ignition Engines	GB 11340-2005
16	Emission Limits and Measurement Methods for Exhaust Pollutants from Vehicle Compression-Ignition and Gas Fueled Ignition Engines	GB 17691-2005
17	Limits and Measurement Methods for Exhaust Pollutants from Vehicles Equipped with Ignition Engines	GB 18285 -2005
18	Limits and Measurement Methods for Emissions from Light Duty Vehicles	GB 18352-2005

Source: ADB PPTA Consultant and domestic EIA report.

40. As noted above, ADB's SPS requires borrowers to follow environmental standards consistent with good international practice as reflected in internationally recognized standards such as the World Bank Group's EHS Guidelines. When host country regulations differ from these levels and measures, the borrower is to achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, the borrower/client is required to provide justification for any proposed alternatives. Both PRC standards and EHS guidelines are used in this assessment as described below.

1. Ambient Air Quality Standards

41. Ambient air quality limits are intended to indicate safe exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Limits are given for one or more specific averaging periods, typically one-hour average, 24-hour average, and/or annual average. The PRC's recently updated *Ambient Air Quality Standards (*GB3095-2012) has two classes of limit values; Class 1 standards apply to special areas such as natural reserves and environmentally sensitive areas, and Class 2 standards apply to all other areas, including urban and industrial areas. The PRC standards for Class 2 areas are applicable for the project.[4]

42. The World Health Organization (WHO) Air Quality Guidelines are recognized as international standards and are adopted by the World Bank Group's EHS Guidelines. In addition to guideline values, interim targets (IT) are given for each pollutant by the WHO as incremental targets in a progressive reduction of air pollution. The WHO guidelines and corresponding PRC standards are presented in **Table II-5**.

43. From a review of **Table II-5**, it can be observed that:

- For TSP, there are PRC standards but no corresponding WHO guidelines.
- For PM_{10}, PRC Class 2 annual average and 24-hour average standards meet WHO IT-1 guidelines (there are no 1-hour average standards or guidelines for either PRC or WHO).
- For $PM_{2.5}$, PRC Class 2 annual and 24-hour standards meet WHO IT-1 guidelines (there are no 1-hour standards or guidelines for either PRC or WHO).
- For SO_2, WHO only has a 24-hour average guideline (0.125 mg/m^3), which is slightly lower than the PRC standard (0.150 mg/m^3). However, SO_2 levels are low in the component area, and the component will only contribute low levels of SO_2, so the very minor difference is inconsequential.
- For NO_2 ,the PRC standard is equivalent to the WHO annual average guidelines, there is no WHO 24-hour average guideline; and the 1-hour average PRC standard is equivalent to the WHO guideline.
- For O_3, the PRC class I 1-hour average standard is equivalent to the WHO 1-hour average guideline and PRC 1-hour average class II standard is equivalent to the WHO IT-1 1-hour average guideline.
- For CO, there are PRC standards but no corresponding WHO guidelines.

4 On 29 February 2012, the China State Council passed the roadmap for ambient air quality standards with the aim of improving the living environment and protecting human health. The Ambient Air Quality Standards (GB 3095-2012) prescribes the first-ever limits for $PM_{2.5}$. It also modified the previous area classifications by combining Class III (special industrial areas) with Class II (residential, mixed use areas).

Table II-5: PRC Ambient Air Quality Standards and WHO ambient air quality guidelines, $\mu g/m^3$.

Air Quality parameter	Averaging period	PRC Ambient Air Quality Standard		WHO/EHS Guidelines	
		Class I	Class II	Interim Targets	Air quality guideline
TSP	annual	80	200	NA	NA
	24-hour	120	300	NA	NA
PM_{10}	annual	40	70	30-70	20
	24-hour	50	150	75-150	50
$PM_{2.5}$	annual	15	35	15-35	10
	24-hour	35	75	37.5-75	25
SO_2	annual	20	60	NA	NA
	24-hour	50	150	50-125	20
	1-hour	150	500	NA	NA
NO_2	annual	40	40	NA	40
	24-hour	80	80	NA	NA
	1-hour	200	200	NA	200
O_3	8-hour	100	160	160	100
	1-hour	160	200	NA	NA
CO	24-hour	4,000	4,000	NA	NA
	8-hour	NA	NA	NA	NA
	1-hour	10,000	10,000	NA	NA

Note: NA= not applicable.
Source: WHO Air Quality Guidelines (2006) in IFC EHS Guidelines (2007), and PRC GB 3095-2012.

44. Overall the PRC standards show a high degree of equivalency to the WHO guidelines or IT-1 values and are adopted for use in this IEE report.

2. Boiler Emissions

45. **Table II-6** presents the relevant PRC national boilers emission standard compared with relevant international standards (*EHS Guidelines for thermal power plants*). The Shandong Provincial standards are more stringent than the *EHS Guidelines*, and the Shandong Provincial standards are applicable to the component.

Table II-6: Relevant Shandong Emission Standards for gas fired boilers and Relevant

International Guidelines

Parameter	***Integrated Emission Standard of Air Pollutants for Shandong Province*** (Table 2 of dB 37/2376-2013)	**EHS Guidelines for Small Combustion Facilities Emissions Guidelines (3MWth-50MWth)** (Boiler)	**Comparison**
Stack Height	Stack height is determined according to the requirements in the approved EIA, and must be > 8 m.	Design stack height according to Good International Practice (GIP) to avoid excessive ground level concentrations and minimize impacts.	PRC standard meets GIP
PM	10 mg/Nm^3	NA	No EHS guideline.
SO_2	50 mg/Nm^3	NA	No EHS guideline.
NO_x	100 mg/Nm^3	320 mg/Nm^3	PRC standard is more stringent than the EHS guidelines

Source: World Bank EHS General Guidelines - Table 1.12 and PRC dB37/2376-2013.

3. Surface Water

46. PRC's *Surface Water Ambient Quality Standard* (GB3838-2002) defines five water quality categories for different environmental functions. For example, Category I is the best, such as water at sources of rivers and National Nature Reserves. Category V is the worst quality, suitable only for agricultural and scenic water uses. Based on information collection and site visit, the surface water bodies near the component site are Xiaoqing River and Daming Lake. Category IV water quality standard (see **Table II-7**) is applicable for Daming Lake which is used as landscape water and Category V water quality standard (see **Table II-7**) is applicable for Xiaoqing River which is used as agricultural water. There are no applicable EHS guidelines or target for water quality in this context, and the PRC standard is adopted for use in this IEE report.

Table II-7: Applicable surface water standard. Unit: mg/l, pH excluded

No.	Parameter	Water Quality Category				
		I	**II**	**III**	**IV**	**V**
1	pH	6-9	6-9	6-9	6-9	6-9
2	Dissolved Oxygen	90% saturation or ≥7.5	≥6	≥5	≥3	≥2
3	COD_{Mn}	≤2	≤4	≤6	≤10	≤15
4	COD_{Cr}	≤15	≤15	≤20	≤30	≤40
5	BOD_5	≤3	≤3	≤4	≤6	≤10
6	NH_3-N	≤0.15	≤0.5	≤1.0	≤1.5	≤2.0

7	TP	≤0.02	≤0.1	≤0.2	≤0.3	≤0.4
	For lakes and reservoirs	≤0.01	≤0.025	≤0.05	≤0.1	≤0.2
8	TN (N for lakes and reservoirs)	≤0.2	≤0.5	≤1.0	≤1.5	≤2.0
9	Copper	≤0.01	≤1.0	≤1.0	≤1.0	≤1.0
10	Zinc	≤0.05	≤1.0	≤1.0	≤2.0	≤2.0
11	Fluoride	≤1.0	≤1.0	≤1.0	≤1.5	≤1.5
12	Selenium	≤0.01	≤0.01	≤0.01	≤0.02	≤0.02
13	Arsenic	≤0.05	≤0.05	≤0.05	≤0.1	≤0.1
14	Total Mercury	≤0.00005	≤0.00005	≤0.0001	≤0.001	≤0.001
15	Cadmium	≤0.001	≤0.005	≤0.005	≤0.005	≤0.01
16	Hexavalent Chromium	≤0.01	≤0.05	≤0.05	≤0.05	≤0.1
17	Lead	≤0.01	≤0.01	≤0.05	≤0.05	≤0.1
18	Cyanide	≤0.005	≤0.05	≤0.2	≤0.2	≤0.2
19	Volatile Phenol	≤0.002	≤0.002	≤0.005	≤0.01	≤0.1
20	Sulfide	≤0.05	≤0.1	≤0.2	≤0.5	≤1.0
21	Petroleum	≤0.05	≤0.05	≤0.05	≤0.5	≤1.0
22	Anionic surfactant	≤0.2	≤0.2	≤0.2	≤0.3	≤0.3
23	Coliforms	≤200	≤2000	≤10000	≤40000	≤40000

Source: PRC GB3838-2002.
Note: COD_{Mn} = permanganate index; CODcr = chemical oxygen demand; BOD_5 = 5 days biochemical oxygen demand; NH_3-N= ammonia nitrogen; TP = Total Phosphorus; TN = Total Nitrogen.

4. Groundwater

47. PRC's *Groundwater Water Ambient Quality Standard* (GB/T14848-2017) also defines a number of water quality categories for different environmental functions. As shallow groundwater bodies near the component site are the springs including Batou, Heihu, Wulong and Zhenzhu in Jian which are primarily used for landscape, the Category III standard is applicable (**Table II-8**). There is no equivalent standard recommended in the *EHS Guidelines,* and the PRC standard is adopted for use in this IEE report.

Table II-8: Applicable groundwater standard.

No.	Parameter	Unit	Category III Standard
1	pH	-	6.5-8.5
2	COD_{Mn}	mg/l	3.0
3	Sulfate	mg/l	250
4	Chloride	mg/l	250
5	Volatile Phenols	mg/l	0.002
6	Total hardness ($CaCO_3$)	mg/l	450
7	Nitrate NO_{3-}	mg/l	20
8	Nitrite NO_{2-}	mg/l	1.0
9	NH_3-N	mg/l	0.5
10	Molybdenum	mg/l	0.2
1	Cyanide	mg/l	0.05
12	Cadmium	mg/l	0.005
13	Chromium VI	mg/l	0.05
14	Arsenic	mg/l	0.01
15	Zinc	mg/l	1.0
16	Fluoride	mg/l	1.0
17	Lead	mg/l	0.01
18	Iron	mg/l	0.3
19	Manganese	mg/l	0.1
20	Copper	mg/l	1.0
21	Selenium	mg/l	0.01
22	Benzene	mg/l	0.01
23	Methylbenzene	mg/l	0.7
24	Total coliforms	/L	3.0
25	Colony forming unit	/L	100

No.	Parameter	Unit	Category III Standard
26	Mercury	mg/l	0.001
27	Total dissolved solid	mg/l	1000

Source: PRC GB/T14848-2017.
Note: COD_{Mn} = permanganate index; CODcr = chemical oxygen demand; BOD_5 = 5 days biochemical oxygen demand; NO_3- = Nitrate; NO_2- = Nitrite; NH_3-N= ammonia nitrogen; TP = Total Phosphorus; TN = total nitrogen.

5. Wastewater Discharge

48. **Table II-9** presents the relevant PRC wastewater discharge standards. The *EHS Guidelines* indicate that wastewater discharged to public or private wastewater treatment systems should: meet the pretreatment and monitoring requirements of the sewer treatment system into which it discharges; not interfere, directly or indirectly, with the operation and maintenance of the collection and treatment systems, or pose a risk to worker health and safety, or adversely impact characteristics of residuals from wastewater treatment operations; and be discharged into municipal or centralized wastewater treatment systems that have adequate capacity to meet local regulatory requirements for treatment of wastewater generated from the project.

49. The component will discharge wastewater to the municipal sewer systems for treatment at nearby wastewater treatment plants (WWTP) of Jinan. The wastewater discharges will be required to meet Class B maximum acceptable concentrations (MACs) in *Wastewater Quality Standards for Discharge to Municipal Sewers* (GB/T 31962-2015), and the WWTP discharges are required to meet Class 1A of *Discharge Standard of Pollutants for Municipal Wastewater Treatment Plants* (GB 18918-2002).

Table II-9: PRC *Wastewater Quality Standards for Discharge to Municipal Sewers*.

No.	Pollutant	Maximum acceptable concentration (MAC) mg/L (except pH and chromacity)
		Class B
1	pH	6.5-9.5
2	SS	400
3	COD	500
4	Ammonia nitrogen	45
5	TDS	2000
6	Chromacity	70
7	BOD	350
8	Total phosphorus	8

Source: PRC GB/T 31962-2015.

6. Noise

50. **Table II-10** presents the relevant PRC *Urban Noise Standards* compared with relevant international guidelines from the WHO (as presented in the *EHS Guidelines*). The classes within the standards are not directly comparable, but the PRC Category I standards are equivalent to WHO Class I standards, Category II standards are less stringent than WHO Class I standards and Category II and III standards are stringent than WHO Class II standards. Because Category II standard is applicable to the component area and Category I standard is applicable to the nearby sensitive receptors, Category II for component area and Category I for sensitive receptors are utilized in this IEE report.

Table II-10: PRC *Environmental Quality Standards for Noise* (GB3096-2008) and relevant international guidelines.

PRC Standards Leq dB(A)			**International Standards One Hour Leq dB(A)**		**Comparison**
Category	**Day** 06-22h	**Night** 22-06h	**Day** 07-22h	**Night** 22-07h	
0: Areas needing extreme quiet, such as special health zones	50	40	WHO Class I: residential, institutional, educational: 55 WHO Class II: industrial, commercial: 70	WHO Class I: Residential, institutional, educational: 45 WHO Class II: Industrial, Commercial: 70	Classes are not directly comparable, but PRC Class II standards exceed WHO Class II standards. PRC standards are utilized in this report.
I: Mainly residential; and cultural and educational institutions	55	45			
II: Mixed residential, commercial and industrial areas	60	50			
III: Industrial areas	65	55			
IV: Area on both sides of urban trunk roads	70	55			

Source: WHO Noise Quality Guidelines (1999) in IFC EHS Guidelines (2007), and PRC GB3096-2008.

51. **Table II-11** presents the relevant PRC and international noise standards (US EPA, there no such WHO or *EHS Guidelines* standards) for on-site construction noise. The PRC standards are more stringent than international guidelines and are utilized in this IEE report. At the sensitive receptors, EHS Guidelines standards will be applied. The PRC's Emission Standard of Environmental Noise for Boundary of Construction Site (GB12523–2011) regulates construction noise, limiting construction noise levels at the construction site boundary to 70 dB(A) in the day time (06:00–22:00 hours) and 55 dB(A) at night (22:00–06:00 hours).

Table II-11: PRC *Noise Emission Standard for Construction Site Boundary* (GB12523-2011) and relevant international guidelines.

Day Leq dB(A)	**Night Leq dB(A)**	**International Standards Leq dB(A)**	**Comparison**
70	55	US EPA: 85 (day, 8-hour exposure)	IFC EHS Guideline: Occupational Health and Safety: 85 (Equivalent level LAeq,8h) 110 (Maximum LAmax, fast)

Source: US EPA, IFC Occupational Health and Safety standard and PRC GB 12523-2011.

During operation noise at site boundaries should comply with Class II of the PRC I*ndustrial Enterprise Boundary Noise Emission Standard* (GB12348-2008) (**Table II-12**).

Table II-12: PRC *Noise Emission* Standard *for Construction Site Boundary* (GB12348-2008) and relevant international guidelines.

Standard Type	**Standard Value Leq dB(A)**	
	Day	Night
Class 2	60	50

Source: PRC GB 12348-2008.

III. PROJECT DESCRIPTION

A. The Project

52. This IEE report has been prepared for the proposed West Jinan Waste Heat Utilization and Clean Energy Component of the Shandong Clean Heating and Cooling Project (the Project) in Shandong Province of the PRC. The proposed Project is the fourth in a multi-year multi-sectoral ADB support for air quality improvement in the greater BTH region.

53. This component will: (i) install district heating network in west Jinan utilizing industrial waste heat as the main heat source to reduce coal use with a district heating of 80 million m^2. The industrial waste heat is from Xinyuan Power Plant (6×600MW water-cooling gen-sets) and Haoji Power Plant (4×360MW water-cooling gen-sets) and transferred through long-distance pipelines to transmit hot water recovered from the waste heat; (ii) provide district heating to 29 communities in west urban area of Jinan which are not connected to the district heating pipeline network by gas-driven heat pump, gas-fired boiler and air source heat pump. The total heating area is 2.5697 million m^2. The component will reduce coal combustion for urban heating, contributing to better air quality in Jinan City.

54. The component will be implemented through three outputs:

(i) **Output 1**: Provide district heating to 29 communities in west urban area of Jinan which are not connected to the district heating pipeline network by gas-driven heat pump, gas-fired boiler and air source heat pump. Total heating area of the component will be 2,569,700 m^2.

(ii) **Output 2**: 93.568 km of primary district heating pipeline network will be constructed to provide district heating to 80 million m^2 in west Jinan by industrial waste heat. The pipe networks will utilize two-pipe system. One is water supply pipe and another is water return pipe; and

(iii) **Output 3**: Strengthened capacity to install and maintain clean heating technologies.

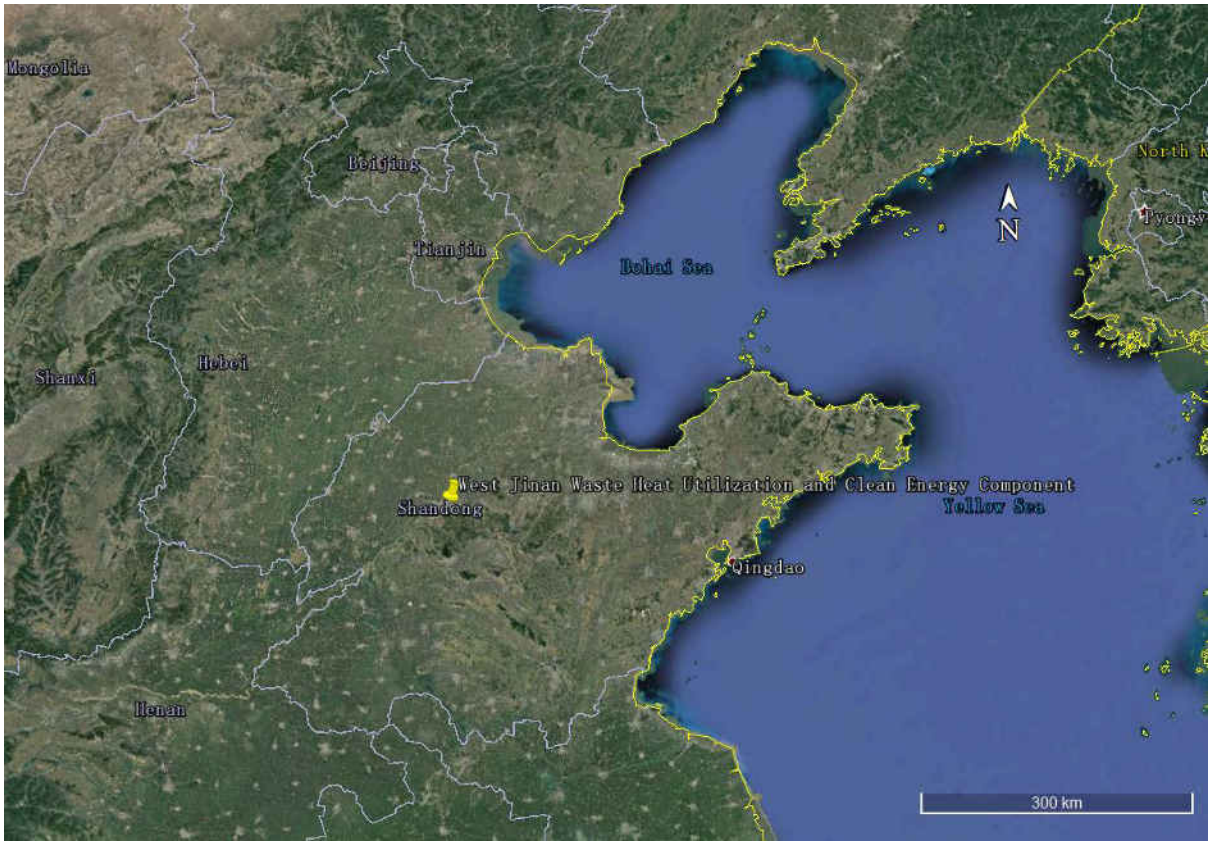
55. The component scope includes: (i) 1x1.5MW, 1x3.5MW, 4x2.8MW, 2x10.5MW and 3x7MW gas fired boilers to provide heating to an area of 1,030,000 m^2; (ii) 40 air source heat pump units to provide heating to an area of 50,200 m^2; (iii) 1,311 gas-driven heat pump units to provide heating to an area of 1,489,500 m^2 and (iv) 93.568 km of primary district heating network to provide district heating to 80 million m^2 in west Jinan by industrial waste heat. Once completed, the component will provide district heating to an area of 82,569,700 m^2.

56. The component impact will be reduced coal consumption, improved air quality and reduced greenhouse gas emissions in Jinan City. The outcome will be improved energy efficiency, a cleaner environment in Jinan City and a reduction in cases of respiratory and heart diseases.

B. Project Location

57. The component will be implemented at west urban area of Jinan City which is located on the central and western areas of Shandong Province (**Figure III-1**). Jinan is capital city of Shandong Province and is comprised of seven urban districts and three rural county-level cities.

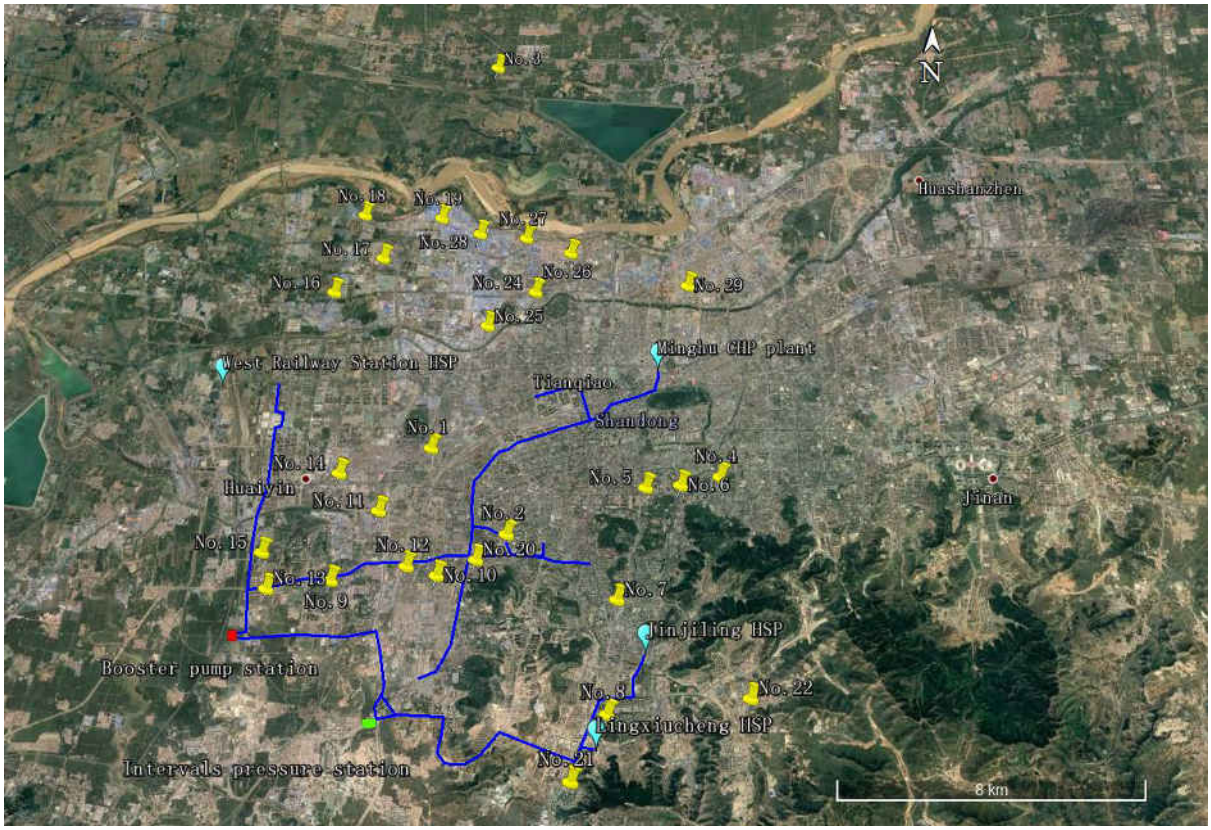
Figure III-1: Component location in Shandong Province.



Source: Google earth, 2018

58. The component is located in Lixia District, Shizhong Distinct, Huaiyin District and Tianqiao District of Jinan City (**Figure III-2)**.

Figure III-2: Component location.



Source: Google earth, 2018.

C. Project Rational

59. Jinan, the capital city of Shandong Province, is situated in the northeastern part of PRC. The winter temperature drops to as low as –19 degree Celsius (°C), and sub-zero temperatures typically last for 4 months a year; under this climate heating service is an essential requirement for sustaining people's livelihoods. Heat demand in Jinan is increasing substantially due to rapid ongoing urban expansion. Current district heating coverage in Jinan is approximately 147 million m^2, compared to 87.6 million m^2 in 2012.

60. The existing heating system in Jinan is a large scale district heating system driven by coal-fired HSPs or CHP plants. However, the expansion of the existing coal-based district heating system to meet the increasing demand is not an option as Jinan has been experiencing significant pollution problems in the winter heating seasons including hazy skies and high levels of particulates.

61. Shandong Province is one of the most important regional economies in the PRC. Its provincial capital, Jinan, is a key economic, political, and transportation center in northern PRC. In 2017, Shandong's economy was ranked the third, contributing 8.79% of the country's total gross domestic product (GDP).

62. In 2017, Shandong's economy grew at 8.46%, among the highest growth rates in the PRC. However, the province's economic growth is energy intensive, highly polluting, and

overwhelmingly dependent on coal, especially for heavy industry and winter space heating. Heavy industry accounts for 68% of the province's industrial output, which is led by chemical production, agro-processing, machinery manufacturing, textiles, and smelting. Its power generation is almost exclusively coal-based.[5] Shandong Province alone consumes 10% of the PRC's total energy consumption. 79.3% of Shandong's primary energy mix is from coal, which makes it the PRC's largest consumer of coal. The province's coal consumption has steadily increased between 2011 and 2015, whereas the entire country has reduced its consumption between 2013 and 2015.[6]

63. As a result, the province is a substantial contributor of air pollution in the Greater BTH region. Jinan City is one of the cities with severe air pollution in the Greater BTH region. In 2017, Jinan ranked 65 among 74 major cities in the PRC, and first in Shandong Province for poorest air quality. Raw coal combustion produces lots of particulate matter and carbon dioxide. The average annual concentration of PM_{10} was measured at 130 micrograms per cubic meter (μg/m³) and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) was measured at 63 μg/m^3. These concentrations were nearly double the national air quality category II standards (70 μg/m³ and 35μg/m³) and more than six times the level recommended by the World Health Organization (20 μg/m³ and 10 μg/m³).[7] Annual concentration levels of other pollutants such as sulfur dioxide (SO_2) at 25 μg/m³ which is compliance with national air quality standard (60 μg/m³), and nitrogen dioxide (NO_2) is 46 μg/m³ which is worse than national air quality standard (40 μg/m³). Exposure to high levels of particulate matter and other air pollutants are associated with health risks such as cardiovascular and respiratory disease.

64. Restructuring the country's energy mix to combat air pollution is at the forefront on the government's agenda for transforming the PRC's economic growth model from an export-driven economy to a consumption-led, low-carbon one. The PRC's 13th Five-Year Plan (2016-2020) coins this goal as transforming the PRC into an "ecological civilization", guided by principles of environment, innovation, sustainability, and inclusive growth. To this end, the Plan includes targets for air quality and $PM_{2.5}$ levels in large cities and for the reduction of energy and carbon intensity. The 13th Five-year Plan builds on the Comprehensive Action Plan for Air Pollution Prevention and Control 2013–2017 (CAAP), which set the strictest air quality measures and targets to date on SO_2, NOx, $PM_{2.5}$, and volatile organic compounds nationally, and for the BTH region. More recently, MEE introduced the Work Program for Air Pollution Control (2017) in the BTH Region and its Surrounding Areas. The program aims to implement strict pollution control measures in 28 cities, of which 7 are located in Shandong province. The program emphasizes the importance to reduce winter raw coal burning for heating supply in urban, semi-urban and rural areas of the BTH region.

65. Coal-based heating is the major cause of rising level of outdoor and indoor air pollution during the winter. According to *Particulate matter (PM) source analysis result in Jinan in 2017* by Jinan EPB, 24.6% of $PM_{2.5}$ and 17.4% of PM_{10} are from coal combustion. According to *Jinan Action Plan (2017-2020) for Clean District Heating Pilot Cities in Northern China*, boilers with a capacity less than 35 t/h are prohibited in Jinan City from 2018. Thus, other alternatives to meet the growing heat demand are urgently required.

66. Although the district heating area in Jinan has increased a lot, there are still many communities in Jinan urban area which are not connected to existing heating system of Jinan. Small coal fired boilers are used in these communities for heating. Based on Clean District heating

[5] HKTDC Research. Shandong: Market Profile. Accessed March 22, 2018.
[6] Yiqing Zhang, Chuangeng Liu, Ke Li, Yong Zhou. 2018 Strategy on China's regional coal consumption control: A case study of Shandong province, *Energy Policy*. 112. pp. 316–327.
[7] Jinan EPB, 2017. The 2017 Bulletin on the Jinan Municipal Air Quality. Jinan.

Pilot City action plan in Jinan (2017-2020), these small coal fired boilers will be dismantled before 2020. These communities will be connected to the existing heating system of Jinan in the future; removable and small equipment is a good choice.

67. Instead of a conventional large scale heating system, the component aims to provide district heating by waste heat, gas fired boilers, electric heat pumps and gas driven heat pumps. The component is more flexible allowing (i) the use of different clean and renewable energy sources; and (ii) after the communities are connected to district heating network, the boilers and heat pump units can be removed and used in other communities.

68. Once operational, the component will: (i) result in annual energy savings equivalent to 1,157,368.0 tce, thereby providing a global public good by avoiding the annual emission of 3,054,491.8 tons of CO_2; (ii) improve local air quality through the estimated annual reduction of emissions of SO_2 by 3,649.5 tons, NOx by 3,638.1 tons, and PM by 609.8 tons; and (iii) eliminate the negative impacts of coal transportation through urban areas by truck or train.

D. Project Scope

69. The components are summarized in **Table III-1**.

Table III-1: Project Components and Key Features.

No.	Component	Characteristics and Special Features
1	Distributed district heating system	1x1.5MW, 1x3.5MW, 4x2.8MW, 2x10.5MW and 3x7MW gas fired boilers; 40 sets of A7W45 air source heat pump units; 1,311 sets of VS/GH gas-driven heat pump units.
2	Pipeline network	93.568 km of primary district heating pipeline network. Pipe diameters of primary pipeline network will be from DN 600 to DN 1,400.
3	Water treatment system	Gas fired boilers will be installed with soften water equipment to produce make up water. The technology will be iron exchange resin.
4	Water supply system	Production water and domestic water will be both from municipal water system.
5	Water drainage system	Production wastewater and domestic wastewater will be discharged to the municipal sewage pipeline network
6	Power distribution equipment	All distributed district heating system will be located at existing or new communities and will utilize local power transformers.

70. Key parameters of the component are summarized in **Table III-1**.

Table III-2: Project Key Parameters.

No.	Parameter	Unit	No.
1	Heat supply area by distributed district heating system	m^2	2,569,700
2	Heat supply area by industrial waste heat	million m^2	80
3	Annual power consumption	GWh	228.44

No.	Parameter	Unit	No.
4	Annual natural gas consumption	m^3	34,280,314
5	Annual standard coal savings	tons	1,157,367.98

E. Implementation Arrangements

71. SPG will be the EA and responsible for overall guidance during project preparation and implementation. JTPC is the IA of the component. A PMO led by the Jinan Municipal Bureau of Housing and Urban-rural Development will be responsible for day-to-day management of the project.

F. Key Project Features

72. Key features of the component are listed below:

1. Energy Efficiency and Environmental Improvement

73. The component will use waste heat from Xinyuan Power Plant (6×600MW water-cooling gen-sets) and Haoji Power Plant (4×360MW water-cooling gen-sets) for heat supply. Waste heat is the cleanest source for heat supply. Except a small amount of electricity needed to transport the heat from normally power plants to customers, there is no emission at all. The pipeline connected from Xinyuan Thermal Power Plant and Haoji Power Plan to Jinan will be 93 km length and will be built by Jinan Government by 2020 following the PRC standards along the right-of-ways of roads. By 2020, west Jinan will achieve coal-free heat supply.

74. The component will also build separate district heating system in 29 communities to replace existing coal fired small boilers. In doing so, it can improve energy efficiency, energy efficiency.

75. Overall, the component is expected to improve the energy efficiency and environmental performance compared to equivalent heat generation through traditional coal-fired sources. Once operational, the component will: (i) result in annual energy savings equivalent to 1,157,368.0 tce, thereby providing a global public good by avoiding the annual emission of 3,054,491.8 tons of CO_2; (ii) improve local air quality through the estimated annual reduction of emissions of SO_2 by 3,649.5 tons, NOx by 3,638.1 tons, and PM by 609.8 tons; and (iii) eliminate the negative impacts of coal transportation through urban areas by truck or train. Once the component is in operation, the loan implementation environment consultant will support the IA in monitoring the offsets and include the information in the environmental monitoring reports submitted to ADB.

2. Large temperature difference waste heat exchange technology

76. Waste heat is the cleanest source for heat supply, which only needs a small amount of electricity to transport the waste heat from the source industrial or power plant to the customers. There are many industrial waste heat sources around Jinan as shown in **Figure III-4**. The waste heat has limited utilization because of its relatively low temperature (below 150°C) and is referred to as low-heat value source, but its temperature is still higher enough for space heating. In the past decades, due to the considerable amount of heat loss for long-distance transport, only a very small amount of waste heat was used to supply heat to the customers who normally reside near to the heating sources. Most of the waste heat was exhausted to the atmosphere. As the material

and insulation technology improved, long-distance heat transport is no longer an issue. A long-distance pipeline will be built to bring waste heat from Xinyuan Power Plant (6×600MW water-cooling gen-sets) and Haoji Power Plant (4×360MW water-cooling gen-sets) to west Jinan as marked red stars in **Figure III-3**. The waste heat will be the main source of district heating for the area in the near future. It will supply heat to about 80 million m^2 of buildings during winter season, with a design capacity of 3,440 MW. By 2020, west Jinan will achieve coal-free heat supply.

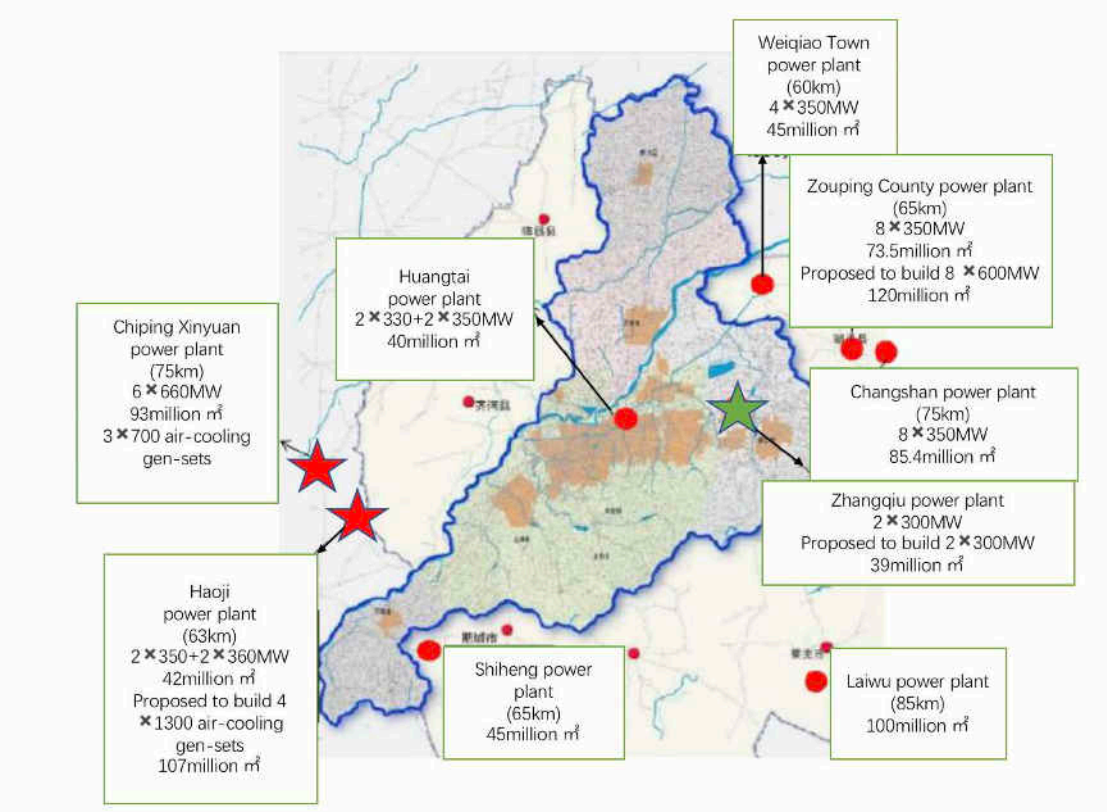


Figure III-3: Waste Heat Sources around Jinan

77. To improve the efficiency of the long-distance pipeline, “large temperature difference” technology is adopted for transporting waste heat to the city, which will increase the heat transport capacity for more than 50% using the same pipelines and at the same time reduce electricity consumption for cycling pumps. The large temperature difference is achieved by lowering the temperature of return water to the primary pipeline. All heat exchange stations (HESs) and energy stations in the project area must switch to large temperature difference heat exchangers to match the primary network. The large temperature difference heat exchanger is an absorption heat pump-based heat exchanger, which replaces traditional plate heat exchangers to get return water temperature below 30°C. This heat exchanger is actually a heat pump which is driven by high temperature water from the primary network (details can be found in the “heat pump” section below). It absorbs additional heat from return water from customers, and further lowers the temperature of return water to the primary network. By using the heat absorption-based exchanger, the temperature of supply and return water changed from 125-120°C /50-60°C to 125-120°C /20-15°C, thus the temperature difference increased to 105°C from the original 60°C.

78. Based on the current status of the existing HESs in Jinan, three kinds of retrofitting will be designed and carried out after pipeline is finished: 1) install large temperature difference heat exchangers if there is enough space; 2) build new relay stations with large temperature difference

heat exchangers between the long-distance pipeline and the energy stations where there is no sufficient space to install the new exchangers; and replace plate exchangers with fixed tube-sheet exchangers in those energy stations. The temperature of return water to relay station will be kept below 50°C; 3) build a pressure isolation heat exchange station between the long-distance pipeline and energy station or relay station in high terrain areas. The layout of district heating system is shown in **Figure III-4**.

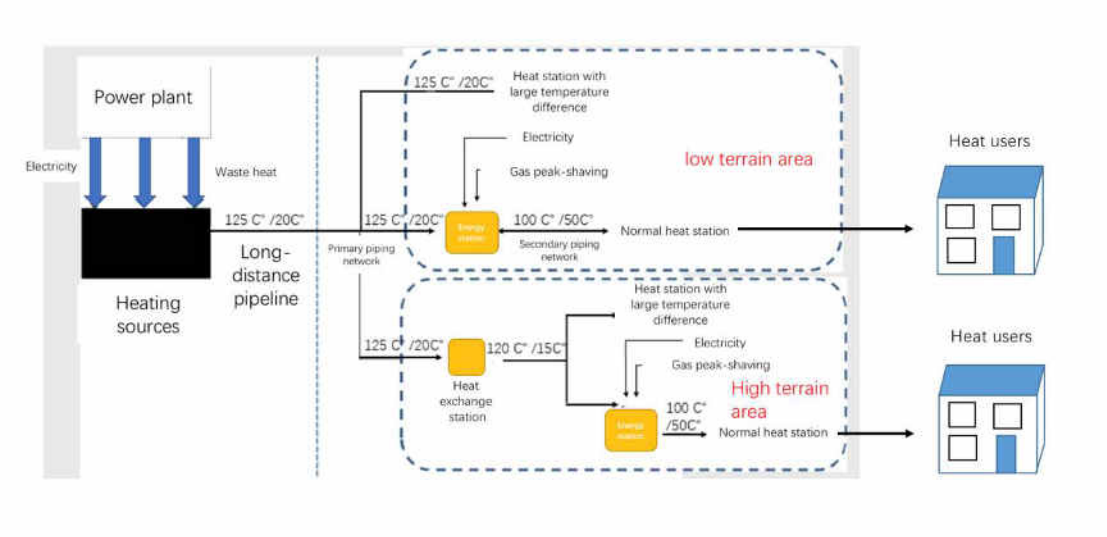


Figure III-4: District Heating System

3. Heat pump

79. A heat pump is a device that absorbs heat from a source at low temperature, increases the temperature of the transferring medium containing this heat by consuming a relatively smaller amount of external high-quality energy, and then releases that heat at a higher temperature than the source. Thus, heat pumps move thermal energy in the opposite direction of spontaneous heat transfer, by absorbing heat from a colder space and releasing it to a warmer one, in the process consuming small amount of energy. This is similar in principle to an air-conditioner or refrigerator but operated in reverse to achieve heating instead of cooling.

80. Based on the different heat sources, heat pumps are classified into three types:

(i) Air source heat pump. This technology utilizes an air source to obtain low-temperature heat. Through the condenser or evaporator from traditional air conditioning equipment, the heat is extracted or released by/from the air by heat exchange. The energy is then transferred into the building by a circulation system to meet residents' demands for hot water and space heating. The air source heat pump working principle diagram is shown in **Figure III-5**. R32 will be used as refrigerant which is not an ozone depleting substance and is not on the ADB's Prohibited Investment Activities List.

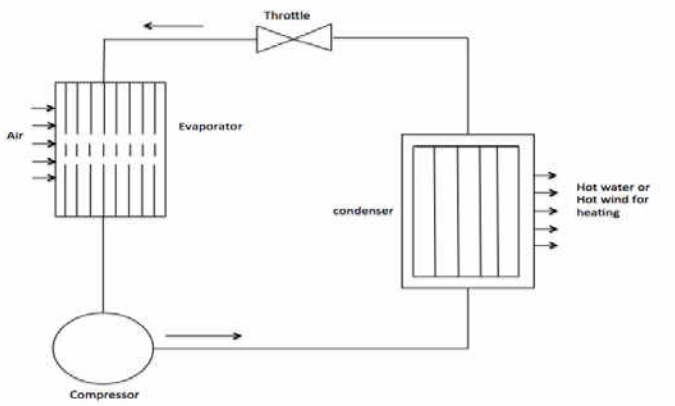


Figure III-5: Diagram of Air Source Heat Pump

(ii) **Water source heat pump.** The working principle of this technology is similar to an air source heat pump, except that it obtains heat from a water body such as sewage plant, lake, and industrial process water etc. A water source heat pump pushes working fluid through the piping network and this fluid absorbs the heat from the surrounding water as it goes. This allows much larger amounts of heat to be carried than the air flow through a given pipe or duct with same cross-section. This working fluid is then compressed by an electric compressor to raise the temperature. A heat exchanger can then be used at the other end to exchange heat from the working fluid, for space heating, water heating and other applications.

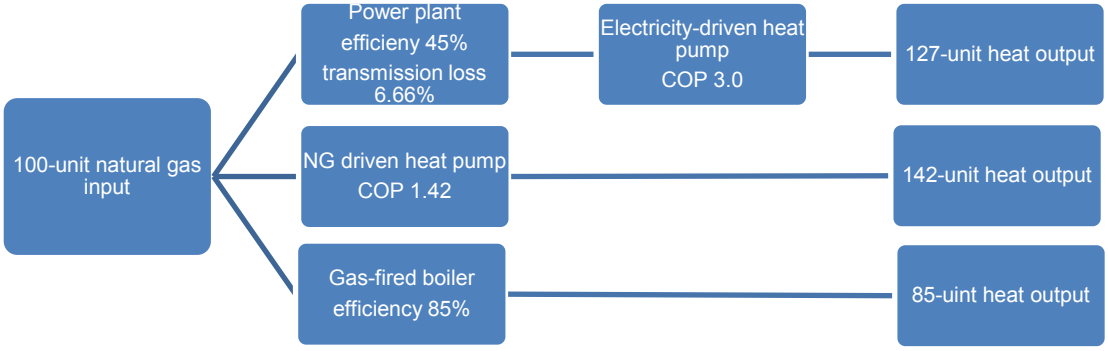
(iii) **Ground source heat pump.** This technology uses shallow-ground heat exchangers as a heat source or sink. Ground source heat pumps work in the same manner as other heat pumps, but exchange heat with the ground and boost it to a higher temperature using air source/water source heat pump. This heat is then used to provide heating or hot water. Ground source heat pumps are simple and often more reliable than air source heat pumps as they do not need fan or defrosting systems and can be installed inside of a building. Although a ground heat exchanger requires a higher investment cost, but the annual operational cost is lower for ground source heat pump as its efficiency is higher than the air source heat pump.

81. Essentially, the heat pump performs the same role as a boiler does in a district heating system, but transports ambient heat from air, water or the ground, rather than burning fuel to provide heat to the users. The heat pump can be driven by electricity, steam/hot water or natural gas. Electricity driven heat pumps are used widely. The steam/hot water driven heat pumps work in the same way as steam turbine. If a cheap steam/hot water available, it is a good option to adopt. The natural gas driven heat pump is a new technology. Considering the losses in electricity generation and transmission, the integrated efficiency of natural gas driven heat pump is more efficient than the electricity driven heat pump and gas fired boilers as shown in **Figure III-6**. It is a good option when switching coal to natural gas with less natural gas consumption which will lead to improved air quality.

82. The component will use two types of heat pumps in different locations based on the availability of energy supply, heat network coverage etc. The steam-driven heat pumps (combined with waste heat) will supply heat to 80 million m^2 buildings, natural gas-driven air-source heat pumps supply heat to 1.4895 million m^2 and electricity-driven air-source heat pumps supply heat

to 50,200 m^2.

Figure III-6: Comparison of Overall Efficiency of Natural Gas to Heat



4. Distributed Gas-fired boiler

83. Although gas-fired boiler is a conventional technology, its advantages of high combustion efficiency, low emission, low maintenance cost and easy to control make it a favorable option to many heat suppliers. There are 5 newly-built residence communities with total area of 1,030,000 m^2 where the heating network does not cover. Gas-fired boilers are selected to supply heat to these communities. After the heating network is extended to these areas in the future, the gas-fired boilers will be used as backup or peak supply source.

G. Component Design Details

1. Location

84. The location of the 29 communities and layout of the pipelines are presented in **Figure III-2.**

85. The heating area of the 29 communities is 2.5697 million m^2. Detailed information is presented in **Table III-3**.

Table III-3: Heat load of the 29 communities.

No.	Community name	Heating area (thousand m^2)	Designed (MW)
1	Huiyuan	30	27 sets of gas driven heat pumps
2	Qingbei Garden	23	21 sets of gas driven heat pumps
3	Longhu Huating	50	45 sets of gas driven heat pumps
4	Gongjijin	7	6 sets of electrically driven heat pumps
5	Tiyuju	11	10 sets of gas driven heat pumps
6	Nanyuan	20	1x1.5MW and 1x3.5MW gas fired boilers

7	Xibabei	3.5	3 sets of gas driven heat pumps
8	Waishichu	50	2x2.8MW gas fired boilers
9	Ronghui City	25	18 sets of electrically driven heat pumps
10	Sansansi	25	27 sets of gas driven heat pumps
11	Xihongmiao	50	45 sets of gas driven heat pumps
12	Baima	50	45 sets of gas driven heat pumps
13	Ronghui Shangyuan	150	135 sets of gas driven heat pumps
14	Shili Rongxiang	150	135 sets of gas driven heat pumps
15	Lvdi Guoji	18.2	16 sets of electrically driven heat pumps
16	Wujiapu	200	160 sets of gas driven heat pumps
17	Xisha	220	176 sets of gas driven heat pumps
18	Haina City	88	72 sets of gas driven heat pumps
19	Lishui Huating	80	64 sets of gas driven heat pumps
20	Luxian Jiayuan	60	2 x 2.8MW gas fired boilers
21	Lingxiu Gongguan	11	13 sets of gas driven heat pumps
22	Huarun Ziyunfu	700	2x10.5MW and 1x7MW gas fired boilers and 35 sets of gas driven heat pumps
23	Zhonggong	200	2x7MW gas fired boilers
24	Tianheyuan	50	42 sets of gas driven heat pumps
25	Jishiyuan	3	2 sets of gas driven heat pumps
26	Yiyuan	25	27 sets of gas driven heat pumps
27	Yanlu Garden	60	50 sets of gas driven heat pumps
28	Jinrong Garden	190	162 sets of gas driven heat pumps
29	Hengda Binhe	20	15 sets of gas driven heat pumps
	Total	2,569.7	NA

Source: FSR report, 2018.

86. Detailed pipeline network information is presented in **Table III-4** and **Figure III-7**.

Table III-4: Primary Pipeline network information.

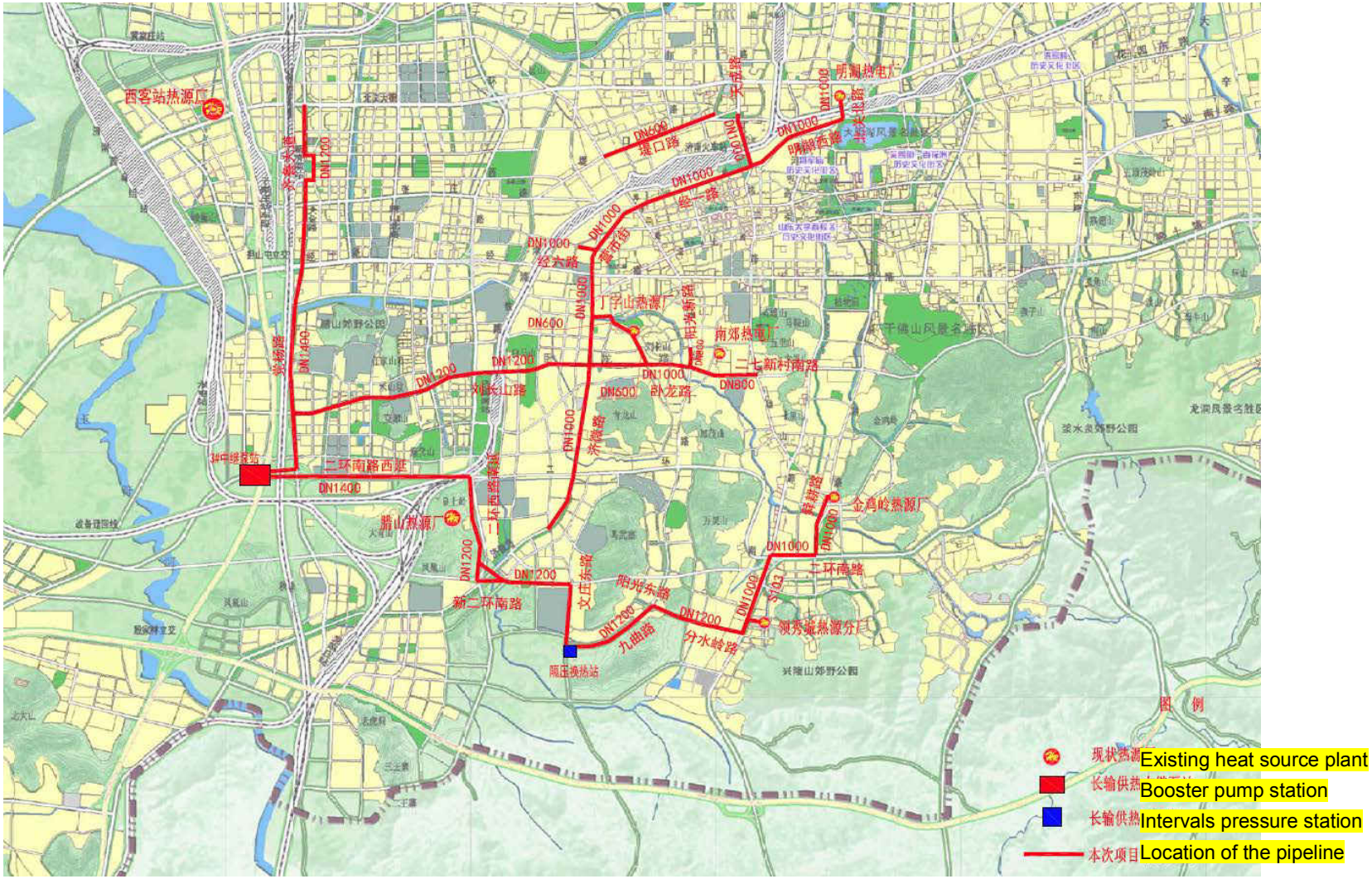
No.	Location	Pipe diameter (millimeter)	Length of pipelines (m)
1	South Erhuan Road West Extension	DN1400	11400
2	South Erhuan Road West Extension	DN1400	3631
3	Dangyang Road	DN1400	4428
4	Qilu avenue	DN1200	3938
5	Wolong Road	DN800	2400
6	Jiwei Road	DN1000	1200
7	Jingliu Road	DN1000	380
8	Liuchangshan Road	DN1200	3500
9	Jingyi Road	DN1000	2500
10	Yangguangxin Road	DN800	470
11	East Xishilihe Street	DN600	768
12	West Xishilihe Street	DN600	918
13	Tiancheng Road	DN1000	980
14	Yingshi Street	DN1000	1706
15	West Minghu Road	DN1000	1500
16	West Erhuan Road South Extension	DN1200	2147
17	South Xinerhuan Road	DN1200	1821
18	East Wenzhuang Road	DN1200	1244
19	Jiuqu Road	DN1200	1980
20	East Yangguang Road	DN1200	500
21	Fengshuiling Road	DN1200	1621
22	S103 Road	DN1000	1740
23	South Erhuan Road	DN1000	924
24	Shungeng Road	DN1000	1248
25	South Erqixincun Road	DN1000	1000
26	North Beiguan Road	DN1000	600

27	Dikou Road	DN600	2500
	Subtotal		46,784
	Total		93,568

Source: FSR Report, 2018.

87. Location of the pipelines is presented in **Figure III-7**.

Figure III-7: Location of pipelines.



Source: Domestic FSR, 2018.

2. Main equipment

88. Information of gas-driven heat pump used in the component is presented in **Table III-5**.

Table III-5: Information of gas-driven heat pump

No.	Item	Unit	Value
1	Heat supply capacity	kW	55.0
2	Circulating water flow rate	m^3/h	7
3	Temperature of supply water	°C	9
4	Temperature of return water	°C	55
5	Maximum natural gas flow	m^3/h	3.5
6	Dimensions	mm	2,523 (length) x1,276 (width)x2,240 (height)
7	Stack height	m	2.5

89. Information of electrically driven heat pump used in the component is presented in is presented in **Table III-6**.

Table III-6: Information of electrically driven heat pump

No.	Item	Unit	Value
1	Heat supply capacity	kW	55.0
2	Coefficient of performance	NA	2.85
3	Circulating water flow rate	m^3/h	12.9
4	Temperature of supply water	°C	10
5	Temperature of return water	°C	60
6	Dimensions	m	2.1 (length) x1.16 (width)x2.0 (height)

3. Wastewater generation and discharge

90. Gas fired boilers will be installed with soften water equipment to produce make up water. The technology will be iron exchange resin and the water is municipal water.

91. The wastewater generated during operation includes domestic wastewater, resin regeneration wastewater, blow down of boilers, wastewater from district heating system and re-generation wastewater of soften water system. Based on operation data from similar projects,

parameters of wastewater are presented in **Table III-7**.

Table III-7: Wastewater analysis data in heating season.

No.	Item	Flow (m^3/d)	COD (mg/L)	Ammonia nitrogen (mg/L)	Petroleum (mg/L)
1	Boiler blow down	50	30	15	--
2	Resin regeneration wastewater	2	150	15	--
3	Heating system blow down	196	135	13	--
4	Domestic wastewater	2.4	200	25	20
	Total	250.4	114.8	29.5	1.6
	Standard	NA	NA	≤500	≤20

Source: PPTA consultant, 2018.

92. Domestic wastewater and production wastewater will be discharged to the municipal sewerage system will be treated at the nearby WWTP All emission concentration of SS, COD, BOD_5 and ammonia nitrogen will be in compliance with of *Wastewater Quality Standards for Discharge to Municipal Sewers* (GB/T 31962-2015) for wastewater discharged to a municipal sewerage system.

4. Solid waste generation

93. The component will have 70 staff during operation period. Estimated domestic waste generated by the component is 2.1 tons per year.[8]

94. The component will use ion exchange resin to produce soften water for the gas fired boilers and gas-driven heat pump units and will generate waste resin during operation period. Based on domestic EIA, the component will change all the resin every four years and 0.5 tons waste resin will be generated. The waste resin is considered as hazardous waste based on PRC laws and regulations which will be collected, stored, transported and treated following the PRC laws and regulations.

5. Environmental protection measures

95. Environmental protection measures of the component are summarized in **Table III-8**.

Table III-8: Environmental protection measures.

Category	Item	Measures
Wastewater	Heating system blow down	To sewage
	Boiler blow down	To sewage
	Resin regeneration wastewater	To sewage

[8] Based on a waste production factor of 0.2 kg/worker/day and 150 working days.

	Domestic wastewater	To sewage
Solid waste	Waste resin	Treated by certificated company
	Domestic waste	Collected and treated by local sanitary department

Source: PPTA consultant, 2018.

6. Fire protection

96. Gas regulation stations and boilers pose a fire and explosion hazard due to the potential for gas leaks. All gas works will be in compliance with relevant PRC building code requirements, including Code for Design of City Gas Engineering (GB 50028-2006) and Regulation on Electric Apparatus Design for Explosion and Fire Risk Environment (GB50058-92). Independent gas regulation station will be constructed 12 meters away from the boilers, gas-driven heat pumps and the residential buildings in the communities, to minimize the risk of explosion damaging other Project facilities or the public. The Jinan Jihua Gas Company will construct and operate the gas regulation stations.

97. The gas regulation stations will be specially designed to withstand and contain explosions, and the stations and the connection to the boilers and gas-driven heat pumps will be equipped with flammable gas detection and alarm systems. In case of a gas leak, automatic shutdown valves will shut down the gas supply, the system will generate audible and visual alarms, and the emergency ventilation system will exhaust gas from the stations so as to protect the building and operators.

98. All other at risk areas will have flammable gas detection and alarm systems able generate audible and visual alarms, and automatic fire suppression systems. All gas related devices will be brightly colored and equipped with warning signs.

99. During detailed design construction and operation phase emergency risk and response plans for each heating zone will be established in accordance with the “National Environmental Emergency Plan” (24 January 2006) and other relevant PRC laws, regulations and standards and will include measures in the World Bank EHS guidelines with respect to occupational and community health and safety. Construction and operation phase Environment, Health and Safety (EHS) plans will also be developed by occupational and gas boilers specialists to ensure worker and community safety.

7. Temporary Worker’s Camps

100. The distributed boilers and heat pumps will be located in 29 communities and HESs for boilers and gas-driven heat pump units will be or have already been built by the developers and the component will only install equipment in the HESs following the PRC standards, no workers’ camp is needed.

101. No workers’ camp is needed for pipeline construction as it is done in phases and a very limited number of workers will be needed for each phase of pipe installation.

IV. DESCRIPTION OF THE ENVIRONMENT

A. Location

102. The component will be implemented at Lixia District, Shizhong Distinct, Huaiyin District and Tianqiao District, Jinan City of Shandong Province. Jinan is located in the north-western part of Shandong province at 36°40′ northern latitude and 116°57′ east of Greenwich, about 400 kilometers south of the national capital of Beijing. It borders Liaocheng to the southwest, Dezhou to the northwest, Binzhou to the northeast, Zibo to the east, Laiwu to the southeast, and Tai'an to the south. In the relief of the region, the city occupies a transition zone between the northern foothills of the Taishan Massif to the south of the city and the valley of the Yellow River to the north. Karst aquifers in limestone formations sloping down from the south to the north give rise to many artesian springs in the city center as well as in surrounding areas.

Figure IV-1: Component site location

Source: https://en.wikipedia.org/wiki/China

B. Shandong Province Overview

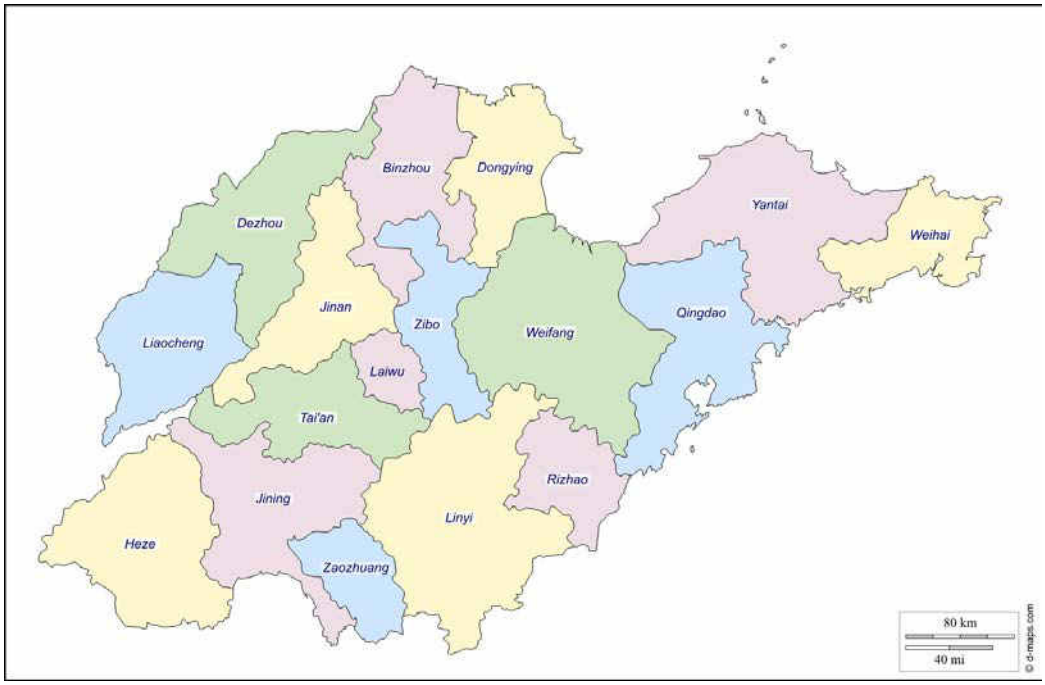
103. Shandong is a coastal province of the PRC and is part of the East China region (**Figure IV-2**). Neighboring provinces are Anhui, Hebei, Henan and Jiangsu.

Figure IV-2: Shandong Province in China

Source: https://en.wikipedia.org/wiki/Shandong

104. Shandong is divided into seventeen prefecture-level divisions including two sub-provincial cities. The seventeen prefecture-level divisions of Shandong are subdivided into 137 county-level divisions (51 districts, 28 county-level cities, and 58 counties). Those are in turn divided into 1941 township-level divisions (1223 towns, 293 townships, two ethnic townships, and 423 sub-districts).

Figure IV-3: Map of Shandong Province administrative divisions



Source: http://d-maps.com

105. In 2016, the population of the province was 99.47 million. The land area is 157,100 km^2 and the length of coastline is 3,100 km. The province has 17 municipalities and 140 counties (including county level cities and districts). Shandong has a temperate climate, with hot, rainy summers and dry, cold winters. Mean annual temperature is 10.5-13.5°C; the average temperature in July is 24-27°C, while the temperature in January is -4-1°C. Mean annual precipitation is 550-950 mm, increasing from northwest to southeast. The province is divided into four topographical zones: (i) Northwestern Shandong Plain, formed by deposits of the Yellow River; (ii) Jiaolai Plain, between central-south Shandong and Jiaodong hilly regions, bounded by bays in the north and south and traversed by the Jiaolai, Weihe and Dagu rivers; (iii) Central-South Shandong hilly area, with elevations >1,000 m above sea level (ASL); and (iv) Jiaodong Hilly Area, the main part of the Shandong Peninsula.

106. Shandong ranks first among PRC provinces in the agriculture production of a variety of products, including cotton and wheat. Other important crops include tobacco, sorghum and maize, as well as peanuts, for which the province is especially well-known, producing nearly a quarter of the country's total. Shandong is also a significant producer of fruits. The province also has extensive deposits of natural gas, iron, diamonds, gold, and bauxite deposits. In 2017, Shandong ranked the third largest provincial economy, contributing 8.79% of the country's total GDP. In 2017, the total GDP of the province was CNY 7.2678.18 trillion and per capita GDP was CNY 72,851.

107. Shandong is one of the leading provinces driving the economic development in the PRC. However, it is facing increasing pressure to reduce its energy consumption and emissions in light of PRC's objective for achieving 40%–45% carbon intensity reduction by 2020 compared to 2005 levels. Shandong was included in the first three provinces to implement province-wide circular economy.

108. The Yellow River passes through Shandong's western areas, entering the sea along Shandong's northern coast; in its traversal of Shandong it flows on a levee, higher than the surrounding land, and dividing western Shandong into the Hai River watershed in the north and the Huai River watershed in the south. The Grand Canal of China enters Shandong from the northwest and leaves on the southwest. Weishan Lake is the largest lake in the province. Shandong Peninsula has a rocky coastline with cliffs, bays, and islands; the large Laizhou Bay, the southernmost of the three bays of Bohai Sea, is located to the north, between Dongying and Penglai; Jiaozhou Bay, which is much smaller, is to the south, next to Qingdao. The Miaodao Islands extend northwards from the northern coast of the peninsula.

109. The province has 30.58 billion m^3 of water resources and 307.4 m^3 per capita in 2016. Based on the standard of water quantity for municipal residential use in Shandong, daily average water consumption per capita is 85-120 l/d. Water resources in Shandong can just meet the requirements. The groundwater resources of Shandong are large, but are being exploited at an unsustainable rate. The demand for groundwater resources will continue to increase in the future with rising population and higher temperatures predicted in climate change scenarios.

C. Site Physical Resources

110. **Topography**. Jinan City occupies a transition zone between the northern foothills of the Taishan Massif to the south-southeast of the city and the Yellow River Valley to the north and northwest. Karst aquifers in limestone formations sloping down from the south to the north give rise to many artesian springs in the city center as well as in surrounding areas. Within the component area the topography is generally flat, sloping slightly downwards from the east to the west and from the southern foothills north to the Yellow River (**Figure IV-4**).

Figure IV-4: Jinan topography

Source: Google map, 2018

111. **Geology and seismicity**. According to domestic EIA, the stratigraphic structure of the component area is simple and stable, without unfavorable geological processes, and is therefore suitable for the component construction.

112. The PRC classifies seismic intensity into 12 grades under the China Seismic Intensity Table (GB/T 17742-2008), based on the severity of "shaking" of the earth surface and the extent of potential impact. According to the China Seismic Ground Motion Parameters Zoning Map (GB18306-2001, Amendment 1), the seismic intensity in the component area is Grade 6, with a design peak ground acceleration of 0.05 g, a 10% probability of exceedance in 50 years, and a return period of 475 years.

113. According to the domestic FSR, the component site is class II under the Code for Seismic Design of Buildings (GB50011-2010), applicable to medium dense and loose gravel, dense and medium dense coarse and sands, and clays with a bearing capacity >250 kPa. The component site is thus considered as suitable for construction activities, and there is no significant risk of potential disasters like landslides, mud flows, land subsidence or geological faults.

114. **Land use.** The boilers and heat pumps will be installed at 29 communities which are located at developing and developed urbanized residential areas, and the pipeline will be

predominantly in existing road right-of-ways (**Figure IV-5)**.

115. **Hydrology.** Jinan lies on the south shore of the Yellow River, and it is the main river in Jinan. With an estimated length of 5,464 km, the Yellow River is the second-longest river in Asia, and the sixth-longest river system in the world. It originates in the Bayan Har Mountains in Qinghai province of western China, then it flows through nine provinces and enters into the Bohai Sea near Dongying in Shandong province. It has a watershed area of 742,443 km^2. The Xiaoqing River is the other main river in Jinan and is the main river near the component site. Originating west of Jinan, it is 220 km long and has a watershed area of 10,336 km^2. It flows south of, and roughly parallel to, the Yellow River, in Jinan passing through Huaiyin, Tianqiao, and Licheng Districts, and also enters into the Bohai Sea. It is fed by a series of tributaries flowing north through the urban areas of Jinan. In recent years it has become contaminated as a result of industrial wastewater and domestic sewage discharges.

116. **Hydrogeology.** The groundwater near the component site is pore phreatic water in loose rock mass. The groundwater at the depth from 0-2,000 m can be divided into shallow freshwater (0-60 m), middle level saltwater (60 – 200 m) and deep freshwater (200- 2,000 m). Based on site visits, all construction sites are generally flat and there are no rivers, streams, ditches, lakes or wells within 500m of the component sites.

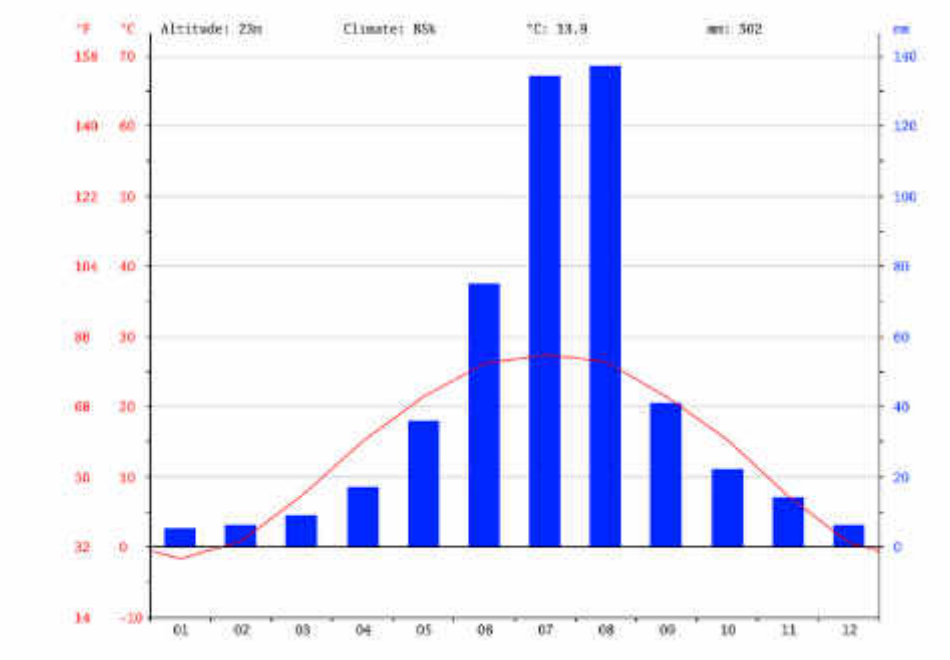
117. **Meteorology and Climate.** Jinan has a temperate continental climate with four distinct seasons. It is dry in the spring, hot and rainy in the summer, cool in the autumn, and dry and cold in the winter. The average annual temperature in Jinan is 16.6°C, the average summer average temperature is 26°C and the maximum recorded summer temperature was 42.7 °C. The average temperature in the 4 coldest months of winter is below 0°C, and the lowest maximum recorded temperature is -19.5°C (**Figure IV-5**).

118. The average annual precipitation is 685 mm, with a recorded maximum of 1,160 mm and a minimum of 320.7 mm. In winter months, precipitation is low (average 20 mm–25 mm/month), and majority of precipitation occurs during the summer months. Average annual average humidity is 58%. The dominate wind direction is from the southeast (**Figure IV-6**).

119. **Sunshine and humidity.** Sunshine hours of Jinan in 2016 were 2,617 hours, or 60.6% of the annual daytime hours.

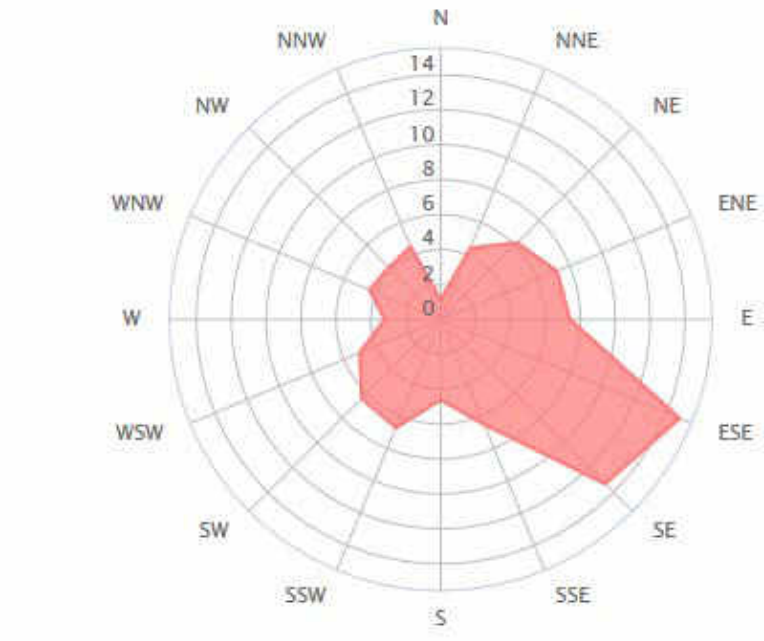
120. **Frost-free Days.** There is an average of 178 frost free days per year. The first frost typically occurs in the first 10 days of October, and the last frost day is typically in the first 10 days of March.

Figure IV-5: Average Temperature Profile of Jinan



Source: https://en.climate-data.org/location/2259/

Figure IV-6: Jinan Wind Rose



Source: https://www.windfinder.com/windstatistics/jinan

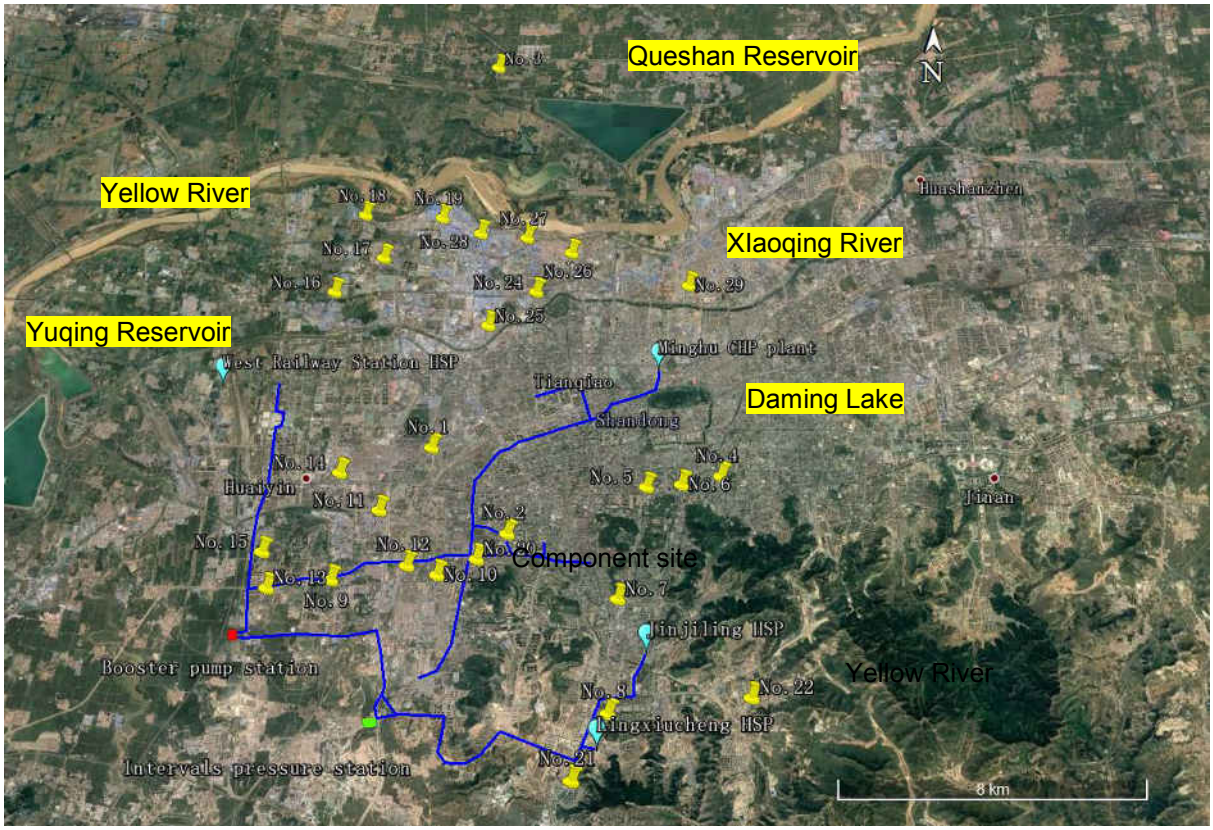
121. **Surface water - rivers and reservoirs**. Surface water resource in the component area is presented in **Figure IV-7**. Jinan lies on the south shore of the Yellow River and south of Tuhai River. Yellow River, Daming Lake and Xiaoqing River are the main rivers in the component area.

122. With an estimated length of 5,464 km, the Yellow River is the second-longest river in Asia, and the sixth-longest river system in the world. It originates in the Bayan Har Mountains in Qinghai province of western China, it flows through nine provinces, and it empties into the Bohai Sea near Dongying in Shandong province. It has a watershed area of 742,443 km^2.

123. The Xiaoqing River is the other main river in Jinan and is the main river near the component site. Originating west of Jinan, it is 220 km long and has a watershed area of 10,336 km^2. It flows south of, and roughly parallel to, the Yellow River, in Jinan passing through Huaiyin, Tianqiao, and Licheng Districts, and also enters into the Bohai Sea.

124. Water reservoirs for drinking water in Jinan include the Queshan, Yuqing, Wohushan, Langmaoshan and Jinxiuchuan. The nearest reservoir is Queshan reservoir which is about 3 km away from No.3 community in southeast direction.

Figure IV-7: Water resources in the component area.



Source: Google earth, 2018.

125. **Groundwater and springs.** Jinan is well known for its artesian karst springs and lakes and is referred to as the Spring City. Daming Lake, located in the historical city center, is the largest lake in Jinan, and one of the city's main natural and cultural landmarks. Fed by the artesian karst springs, the lake maintains a fairly constant water level and temperature throughout the

entire year. Other key karst artesian springs include Batou, Heihu, Wulong and Zhenzhu, and in total there are more than 70 named springs in Jinan. There are no reservoirs or springs in the component site and the nearest spring is Baotu Spring which is about 1.5 km away from No.5 community in north direction.

126. Annual average surface water resource of Jinan City in 2017 is 1,158 million m^3 and underground freshwater resource is 958 million m^3. The total water resource is 2,116 million m^3. The per capita water resource is only 292 m^3.[9] Based on the standard of water quantity for municipal residential use in Shandong, daily average water consumption per capita is 85-120 l/d. Water resources in Jinan can just meet the requirements.

D. Ambient environment baseline and environmental monitoring

127. **Baseline data.** According to Jinan's Environmental Quality Bulletin (2017), urban air quality in Jinan has improved compared with 2016, but pollution levels remain high. The quality of drinking water sources is good but surface water quality has slightly improved. The acoustic environmental quality is relatively good and biological environment is ordinary.

1. Air Quality Monitoring

128. **Air quality index**. MEE monitors air pollution in cities throughout the PRC and presents the results in an Air Quality Index (AQI) based on the level of 6 pollutants (**Figure IV-8**).

129. The AQI was introduced in 2012 and replaces the old Air Pollution Index (API). The MEE measures airborne pollution using AQI. The AQI is based on the concentration levels of six major atmospheric pollutants: SO_2, NO_2, PM_{10}, carbon monoxide (CO), ozone (O_3), and $PM_{2.5}$. The AQI is employed at monitoring stations in 367 cities across the nation.

130. The MEE measures and assigns an individual air quality score (IAQI) to each of the six pollutants over a period of one, eight, or 24 hours. A city's final AQI is the highest of those six scores with that particular pollutant being the city's major pollutant. When the index is lower than 50, the ministry does not name the major pollutant. The AQI ranges from zero to over 300.

[9] Jinan Water Affairs Bureau, 2017. The 2016 Bulletin on the Jinan Water Resource. Jinan.

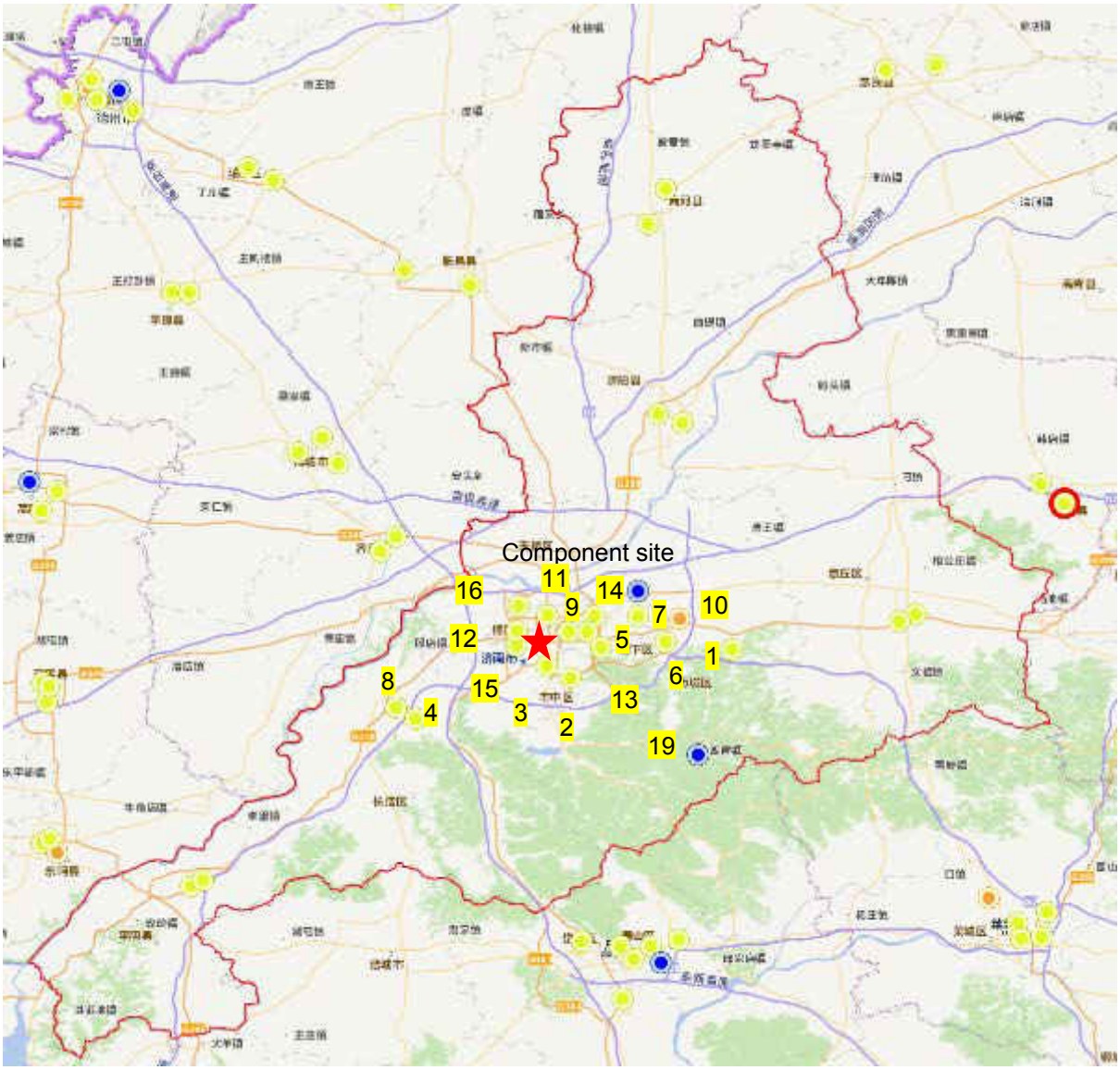
Figure IV-8: The PRC's Air Quality Index (AQI) System

AQI	Air Pollution Level	Health Implications
0–50	Excellent	No health implications.
51–100	Good	Few hypersensitive individuals should reduce outdoor exercise.
101–150	Lightly Polluted	Slight irritations may occur, individuals with breathing or heart problems should reduce outdoor exercise.
151–200	Moderately Polluted	Slight irritations may occur, individuals with breathing or heart problems should reduce outdoor exercise.
201–300	Heavily Polluted	Healthy people will be noticeably affected. People with breathing or heart problems will experience reduced endurance in activities. These individuals and elders should remain indoors and restrict activities.
300+	Severely Polluted	Healthy people will experience reduced endurance in activities. There may be strong irritations and symptoms and may trigger other illnesses. Elders and the sick should remain indoors and avoid exercise. Healthy individuals should avoid out door activities.

Source: Li and Dong-Jun Liu (2014) and http://multimedia.scmp.com/china-air-pollution-in-2014/

131. **Air quality in Jinan City**. There are 21 automated air quality monitoring stations in Jinan City, 14 of them are in the urban area (**Figure IV-9**). Pollutants monitored in the stations include PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, and O_3. Summary data on stations and monitoring results for 2017 are presented in **Table IV-1**.

Figure IV-9: Location of Jinan EPB Automated Continuous Air Quality Monitoring Stations.



Source: Jinan EPB, 2018.

Table IV-1: Air Quality Index and Annual Mean Ambient Air Quality at Monitoring Stations in Jinan City, 2017. (Unit: μg/m^3, excluding CO)

No.	Station name	District	No. of Good AQI days[10]	PM_{10}	$PM_{2.5}$	SO_2	NO_2	CO (mg/m^3)	O_3 (8 hours)
1	Business, Vocational & Technical College	Licheng	196	93	53	28	28	2.0	215
2	Shandong Luneng	Shizhong	220	122	57	19	36	1.7	171
3	Cadre's Sanitarium	Shizhong	220	121	59	19	39	1.8	172

[10] Good AQI days mean the AQI is no more than 100.

4	Changqing college town	Changqing	178	99	56	24	45	1.9	216
5	Economic college	Lixia	192	114	60	20	38	2.1	204
6	Experimental school	High Tech Zone	224	133	60	28	46	2.0	152
7	Development zone	High Tech Zone	176	117	57	29	43	2.1	217
8	Party school	Changqing	167	121	63	28	44	1.9	200
9	Quancheng square	Lixia	204	131	63	25	45	2.1	174
10	Building engineering school	Licheng	187	127	57	29	51	2.2	202
11	Jinan Chemical Factory	Tianqiao	202	125	60	25	62	2.1	163
12	Agricultural Science Institute	Huaiyin	162	149	62	23	49	2.3	194
13	Provincial seed warehouse	Licheng	158	133	69	27	51	2.4	189
14	Municipal monitoring station	Lixia	153	131	70	29	51	2.1	219
15	The 2nd machine tool factory	Huaiyin	138	144	76	25	51	2.4	202
16	Lanxiang Vocational School	Tianqiao	135	151	77	28	53	2.4	190
17	Jinan Baosheng	Licheng	—	—	—	—	—	—	—
18	Jinan City	—	186	130	63	25	46	2.1	190
19	Paomaling	Changqing	262	81	44	22	17	1.0	172
20	Jinping middle school	Lixia	234	125	55	18	42	1.8	158
21	City Museum	Lixia	197	112	59	27	27	2.3	196
22	Western urban area	Huaiyin	156	142	64	24	44	2.2	207

Note: 1. Shading denotes exceedance of relevant standard (Class II of Ambient Air Quality Standard GB3095-2012).

2. Because Jinan Baosheng station stopped operation from October 2017, annual data is not available.

132. Among 21 stations, Station 1, Station 2 and Station 3 rank top three while Station 14, Station 15 and Station 16 rank last three. Station 14 is the nearest station to proposed component site and the distance is around 5.5 km.

133. In 2017, annual average concentrations of PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, and O_3 in Jinan were 130 μg/m^3, 63 μg/m^3, 25 μg/m^3, 46 μg/m^3, 2.1 mg/m^3 and 190 μg/m^3, respectively (**Table IV-2)**. Of these, the concentrations of PM_{10}, $PM_{2.5}$, NO_2, and O_3 exceeded the National Ambient Air Quality Standard (GB3095-2012) by 0.86, 0.80, 0.15 and 0.19 times, while the concentrations of sulfur dioxide and carbon monoxide met the PRC standard. The concentrations of O_3, CO and NO_2 are slightly increased compared to 2016, while concentrations of PM_{10}, $PM_{2.5}$ and sulfur dioxide, are decreased by 7.8%, 13.47% and 34.2%, respectively.

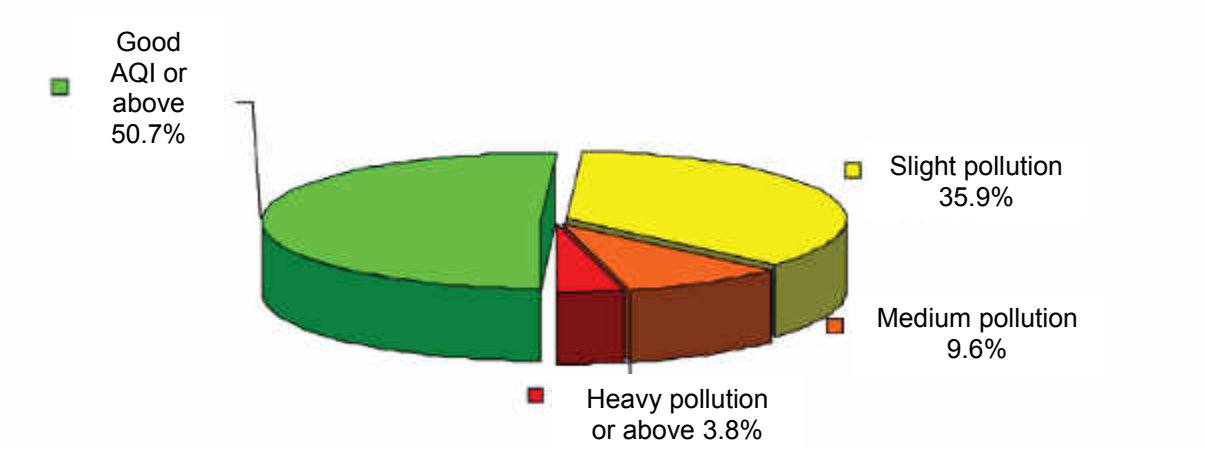
Table IV-2: 24-hour Mean Ambient Air Quality in 2017 Jinan City Urban Area (unit: μg/m^3, excluding CO).

No.	Item	PM_{10} (μg/m^3)	$PM_{2.5}$ (μg/m^3)	SO_2 (μg/m^3)	NO_2 (μg/m^3)	CO (mg/m^3)	O_3 (8 hours)
1	Range of 24-hr mean concentrations	15-504	10-266	7-99	15-103	0.4-5.9	6-275
2	Samples exceeding the standard, %	27.1%	27.4%	0	3.0%	0.8%	19.5%
	Samples exceeding WHO Guidelines, %	81.1%	83.2%	16.5%	NA	NA	49.1%
3	Annual mean concentration	130	63	25	46	2.1	190
4	Ratio of average 24-hr concentration exceedance of standard	0.86	0.80	In compliance	0.15	In compliance	0.19
5	Change compared to 2016, %	-7.8%	-13.47%	-34.2%	2.2%	5.0%	1.1%
6	24-hr mean standard (GB3095-2012)	150	75	150	80	4	160
7	Annual mean standard (GB3095-2012)	70	35	60	40	—	—
8	24-hr mean WHO Guideline	50	25	20	NA	NA	100
9	Annual mean WHO Guideline	20	10	NA	40	NA	NA

Source: Jinan Environmental Quality Bulletin (2017).

134. In 2017, Jinan had 186 days with a Good AQI level, an increase of 22 days over 2016. 14 days were Heavily Polluted or Severely Polluted AQI level, a decrease of 4 days compared to 2016. The frequency distribution of all levels of AQI in 2017 is presented in **Figure IV-10**.

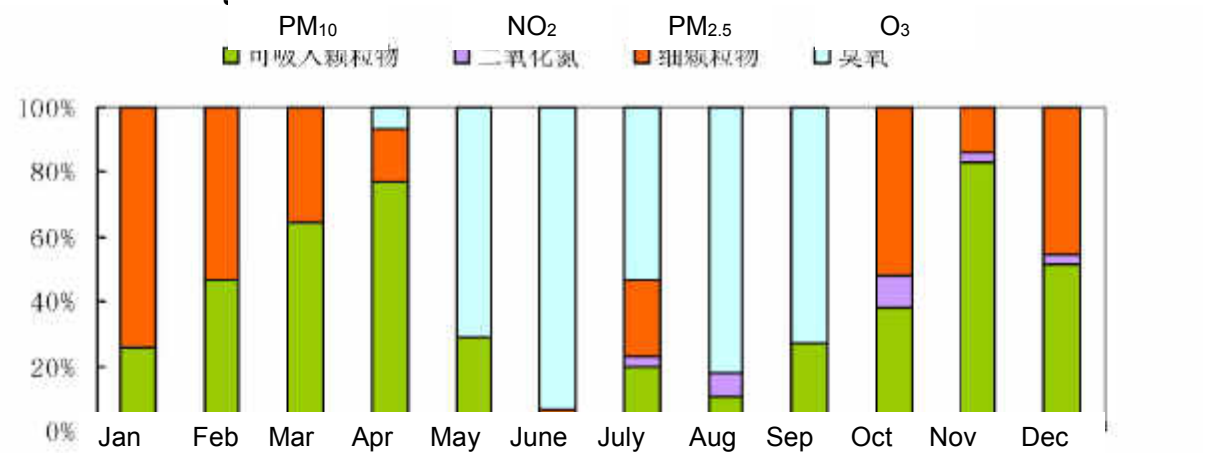
Figure IV-10: AQI Levels in Jinan, 2017.



Source: Jinan Environmental Quality Bulletin (2017).

135. In 2017, PM_{10}, $PM_{2.5}$ and O_3 were identified as primary pollutants on 141, 96 and 122 days respectively. Fine particulates are more frequently primary pollutants in the heating season (November to February) due to coal-based heating, and less so in the summer. O_3 is generally identified as the primary pollutant from May to September, with the highest level in June (**Figure IV-11**).

Figure IV-11: Distribution of Primary Pollutants in Jinan, 2017.



Source: Jinan Environmental Quality Bulletin (2017).

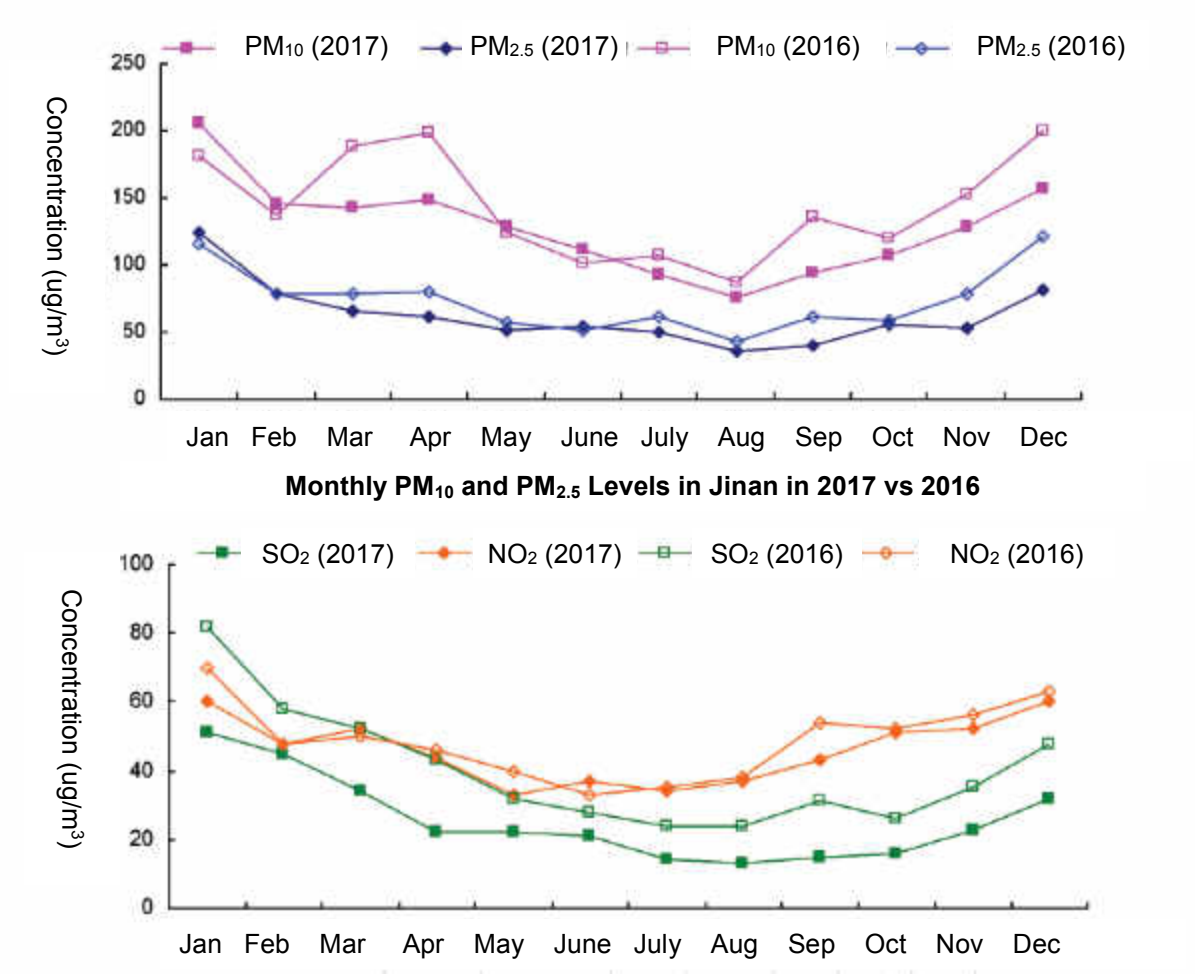
136. In 2017, MEE ranked Jinan's AQI tenth from the bottom of a list of 74 key environmental protection key cities.

137. **Monthly variation of pollutants.** Pollutant levels in Jinan vary substantially over a year, with concentrations typically being higher during the winter heating season and lower in the summer. In 2017 the monthly average concentration of PM_{10} in the worst month (January) was 2.71 times higher than in the lowest month (August). Similarly, the monthly average concentration of $PM_{2.5}$ in January was 3.44 times that of the month with lowest average concentration (August). The monthly average concentration of SO_2 in the worst month (January) was 3.92 times higher than in the lowest months (August), and the monthly average concentration of NO_2 in the worst

month (January and December) was 1.82 times higher than in the lowest month (May).

138. Compared with 2016, PM_{10} concentrations in Jinan in 2016 were higher in January, February and June, consistent in May, and lower in the remaining months; $PM_{2.5}$ concentrations were higher in January, consistent in February, June and October and lower in the remaining months; SO_2 concentrations were lower in all twelve months; and NO_2 concentrations were lower in the January, May and September and consistent in remaining months (**Figure IV-12**).

Figure IV-12: Average Monthly Concentration of $PM_{2.5}$, PM_{10}, SO_2 and NO_2 in 2016 and 2017.



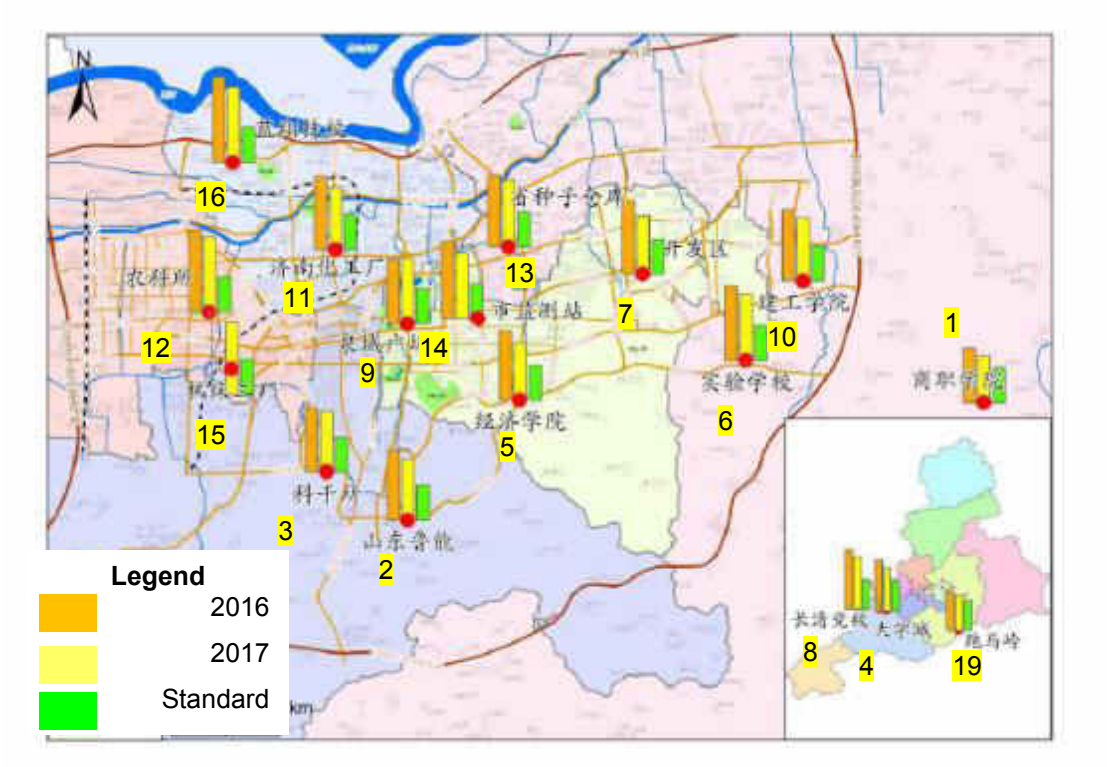
Source: Jinan Environmental Quality Bulletin (2017).

139. **Spatial variation of pollutants.** According the Jinan Environmental Bulletin, in 2017 the annual average concentration of PM_{10} exceeded the Class II annual standard (Ambient Air Quality Standard GB3095-2012) at all monitoring stations and was highest in west and northwest and lowest in the southeast (**Figure IV-13**). The annual average concentration of PM2.5 exceeded the Class II annual standard at all monitoring stations and was highest in northwest and southwest and central core area, and lowest in the southeast (**Figure IV-14**).

140. **The** annual average concentration of SO_2 met the Class II annual standard at all monitoring stations and was highest in the east and central core area, and lowest in the south

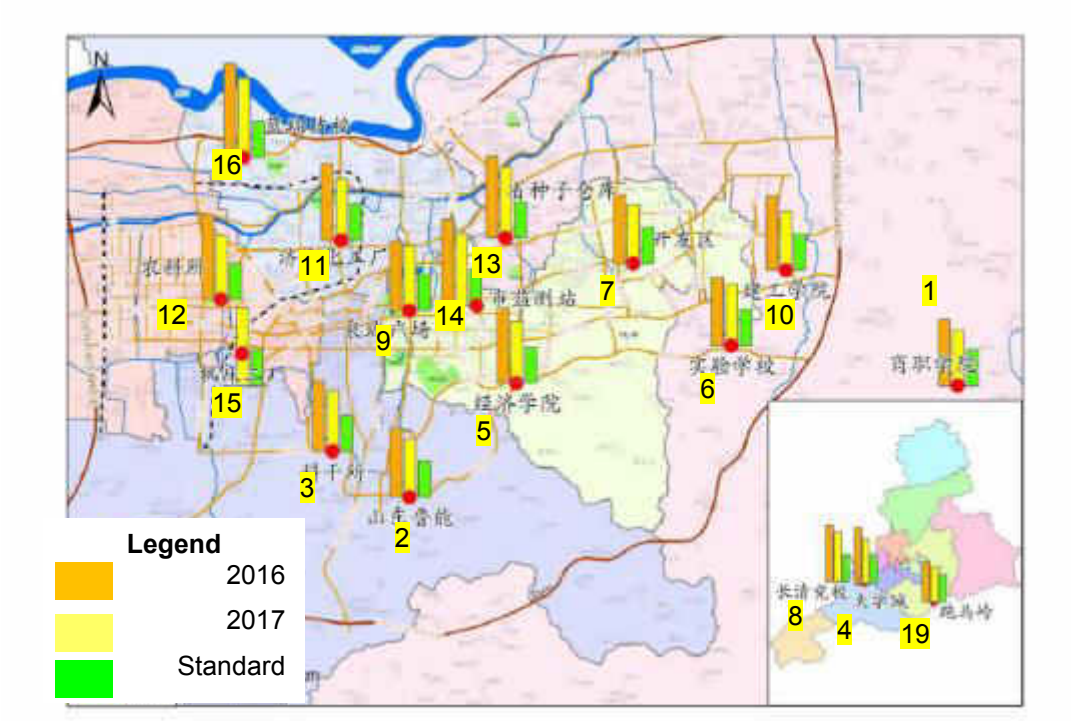
(**Figure IV-15**). The annual average concentration of NO_2 exceeded the Class II annual standard at all monitoring stations except station 1, 2, 3 and 5 and was highest in the northwest and central core area, and lowest in the southeast (**Figure IV-16).**

Figure IV-13: Average Annual Concentrations of PM_{10} at National, Provincial, and Municipal Monitoring Stations in Jinan City urban area, 2016 and 2017.



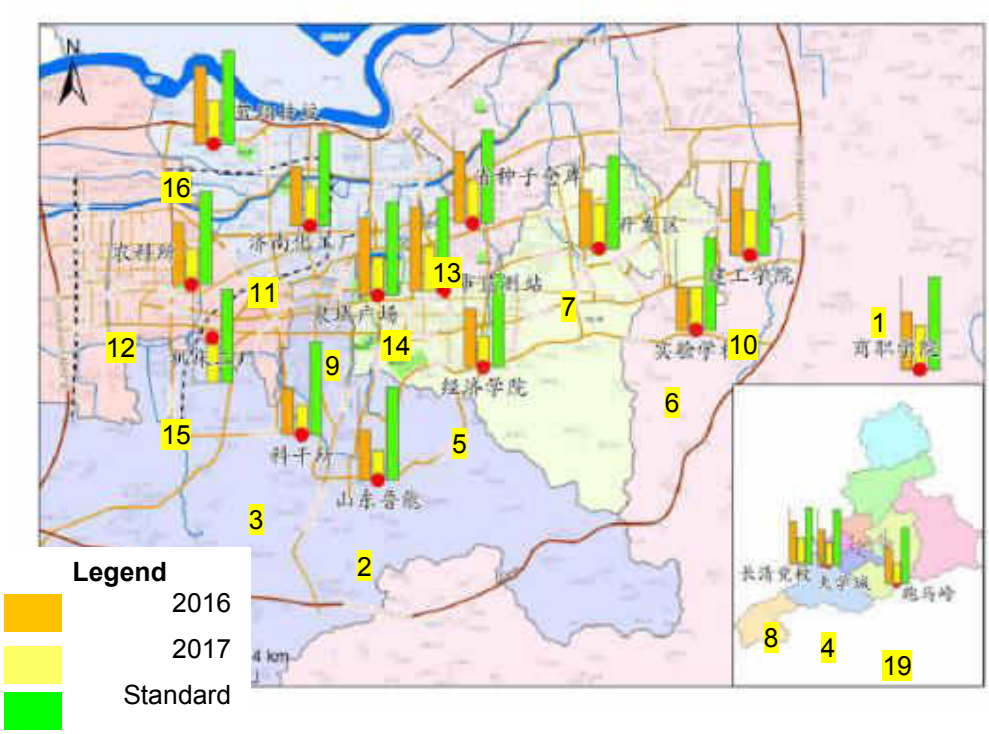
Source: Jinan Environmental Quality Bulletin (2017).

Figure IV-14: Average Annual Concentrations of $PM_{2.5}$ at National, Provincial, and Municipal Monitoring Stations in Jinan City urban area, 2016 and 2017.



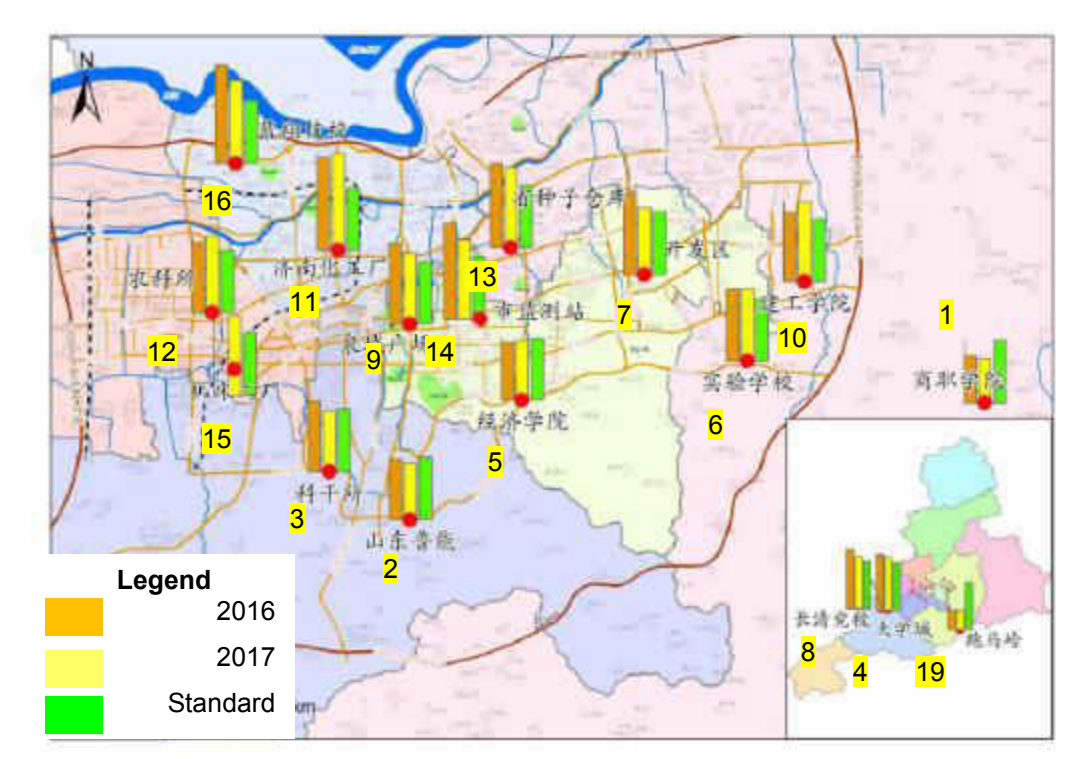
Source: Jinan Environmental Quality Bulletin (2017).

Figure IV-15: Average Annual Concentrations of SO_2 at National, Provincial, and Municipal Monitoring Stations in Jinan City urban area, 2016 and 2017.



Source: Jinan Environmental Quality Bulletin (2017).

Figure IV-16: Average Annual Concentrations of NO_2 at National, Provincial, and Municipal Monitoring Stations in Jinan City urban area, 2016 and 2017.



Source: Jinan Environmental Quality Bulletin (2017).

2. Haze

141. In 2017, 153 days were considered to be hazy, of which 76.5% were slightly hazy, 16.3% were mildly hazy, 2.6% were medium hazy, and 4.6% were seriously hazy. During hazy days the average concentrations of PM_{10}, $PM_{2.5}$, SO_2 and NO_2 were 160 μg/m^3, 90 μg/m^3, 29 μg/m^3, and 54 μg/m^3. SO_2 was in compliance with Class II annual standard (Ambient Air Quality Standard GB3095-2012), and the PM_{10}, $PM_{2.5}$ and NO_2 exceeded the PRC standard by 1.29 times, 1.57 times and 0.35 times, respectively.

142. During hazy days the average concentrations of PM_{10}, $PM_{2.5}$, SO_2 and NO_2 are 48.1%, 104.5%, 26.1%, and 35.0% higher than concentrations in non-hazy days. The data is presented in **Table IV-3**.

Table IV-3: Ambient Air Quality data in hazy and non-hazy days (unit: μg/m^3, excluding CO).

Weather	Item	PM_{10}	$PM_{2.5}$	SO_2	NO_2	CO (mg/m^3)	O_3 (8 hours)
Hazy	Concentration	160	90	29	54	2.5	152
	Exceedance of standard, %	1.29	1.57	In compliance	0.35	In compliance	In compliance

Non-hazy	Concentration	1.08	44	23	40	1.2	206
	Exceedance of standard, %	0.54	0.26	In compliance	In compliance	In compliance	0.29
Annual mean standard (GB3095-2012)		70	35	60	40	4	160

Source: Jinan Environmental Quality Bulletin (2017).

143. Based on Jinan Environmental Quality Bulletin (2017), air quality in the component area is poor, with 24-hour mean concentrations of PM_{10}, $PM_{2.5}$, SO_2, NO_2 and TSP exceeding the PRC and WHO standards.

3. Groundwater quality

144. There are both groundwater and surface water sources of drinking water in Jinan.

145. In 2017, 39 parameters were monitored at the Dongjiao and Dongyuan Water Plants, both of which utilize groundwater as a source of drinking water. The Dongyuan Water Plant is 10.8 km away from the component in east direction while Dongjiao Water Plant is 8.6 km away in west direction. Groundwater is extracted at the depth of 30m at the two plants. The Dongjiao Water Plant achieved the Class III standard of Underground Water Quality Standard (GB/T 14848－2017), and compared with 2016, total hardness, permanganate index, sulfate, electrical conductivity and fluoride concentrations decreased slightly, while NO_3-N increased slightly, and NH_3-N was consistent. The Dongyuan Water Plant also achieved the Class III standard, and compared with 2016, sulfate and NO_3-N decreased slightly while total hardness increased slightly and permanganate index, NH_3-N, fluoride concentration and electric conductivity increased slightly (**Table IV-4**).

Table IV-4: Monitoring Results of Groundwater at Water Supply Plants (Unit: mg/L).

Name	Year	pH	Total hardness	Sulfate	Permanganate index	NO_3-N	NO_2-N	NH_3	Fluoride	Conductivity
Dongjiao water supply plant	2017	7.61	391	76.54	0.65	11.63	0.0028	0.032	0.274	82.6
	2016	7.39	40	89.58	0.69	9.35	0.0030	0.026	0.282	94.5
Dongyuan water supply plant	2017	7.61	391	87.28	0.64	10.53	0.0025	0.031	0.257	84.9
	2016	7.40	387	90.00	0.64	10.80	0.0015	0.028	0.255	84.7
Limit		6.5-8.5	450	250	3.0	20	0.1	0.5	1.0	—

Source: Jinan Environmental Quality Bulletin (2017).

146. Main springs. Monitoring of 24 parameters is undertaken for the four big spring groups (Baotu, Heihu, Wulong and Zhengzhu) in January and July. The four big spring groups are located at urban area of Jinan which are about 5.0 km away from the component in west direction. All parameters for 2016 and 2017 complied with the Class III standard of Underground Water Quality Standard (GB/T 14848－2017) (**Table IV-5**).

Table IV-5: Water Quality Monitoring Results for the Four Main Spring Groups, Jinan City Urban Area, 2016 and 2017. (Unit: μg/L, except pH)

Name	Year	pH	Total hardness	Sulfate	Permanganate index	NO_3-N	NO_2-N	NH_3	Fluoride
Baotu	2017	7.77	363	74.0	0.61	9.16	0.003	0.019	0.173
	2016	7.62	344	78.3	0.77	8.93	0.003	0.025	0.203
Heihu	2017	7.87	415	95.2	0.68	10.07	0.003	0.015	0.196
	2016	7.58	380	92.4	0.57	10.79	0.003	0.025	0.214
Wulong	2017	7.68	311	76.6	0.41	7.91	0.003	0.020	0.249
	2016	7.67	319	84.6	0.83	7.8	0.004	0.053	0.266
Zhengzhu	2017	7.67	327	83.5	0.71	7.59	0.005	0.028	0.232
	2016	7.71	306	84.9	1.00	6.54	0.005	0.03	0.312
Limit		6.5-8.5	450	250	3.0	20	0.1	0.5	1.0

Source: Jinan Environmental Quality Bulletin (2017).

147. Because the component will not have impacts to ground water, ground water monitoring will not be conducted.

4. Surface water quality

148. Key surface water bodies in Jinan City include the Yellow River (Jinan section), the Xiaoqing River (Jinan section) and its tributaries (including the Tuhai River located to the north of the Yellow River, outside the component assessment area), Daming Lake and a number of reservoirs. Both the Yellow River and the Xiaoqing River are drinking water sources should comply with the Class III standards of the Surface Water Environmental Quality Standards (GB3838－2002).The urban sections of the Xiaoqing River and its tributaries are primarily used as a source of landscape water, while the Huanxiangdian section downstream as well as its tributary are agricultural water, all of which should comply with Class V standards of the Surface Water Environmental Quality Standards (GB3838－2002). Daming Lake is classified for non-contact entertainment water, and Tuhai River is classified for industrial water. Both should comply with the Class IV standards of the Surface Water Environmental Quality Standards (GB3838－2002). The reservoirs are drinking water sources and should comply with the Class III standards.

149. **Table IV-6** presents a summary of water quality compliance with Surface Water Environmental Quality Standards (GB3838－2002), Jinan City, 2017.

150. One section of Yellow River is monitored on a monthly basis for 31 parameters. All parameters can meet class III standard.

151. Four sections of Xiaoqing River are monitored on a monthly basis for 26 parameters. Water quality of the Mulizhuang section at the source comply with class III standards and water quality of left three sections do not comply with class V standard. The annual average

concentrations of COD and NH_3-N of the Mulizhuang section of the Xiaoqing River were respectively 8 mg/L and 0.49 mg/L, both of which complied with class III standards. The majority of Xiaoqing River tributaries in Jinan City in 2017 did not comply with relevant standards, primarily for NH_3-N and total phosphorus (TP).

152. There are 12 branches of Xiaoqing River in Jinan and each branch has one monitoring section. Xiahouqiao and Zhanagqigou sections are monitored on a monthly basis for 26 parameters while other sections are for 11 parameters. Sections of Beitaiping River, Gongshang River, Xiluo River, Xingji River and Quanfu River do not comply with class V standards, primarily for NH_3-N and COD. Other sections comply with class V standards.

153. Three sections of Tuhai River are monitored on a monthly basis for 26 parameters. Water qualities of the all sections comply with class IV standards.

154. Three points of Daming Lake are monitored on a monthly basis for 34 parameters. In 2017, water quality in Daming Lake complied with class IV standards, thus meeting the requirements of non- human body direct contact with recreational water area. Compared with 2016, the concentration of total nitrogen increased 4.7%, and the lake is slightly to moderately eutrophic.

155. Main reservoirs in Jinan City are Queshan, Yuqing, Jinxiuchuan, Wohushan and Langmaoshan reservoirs. Each reservoir has two monitoring sections: one in inlet and the other in outlet. In 2017, water quality of Queshan, Yuqing, Jinxiuchuan, Wohushan and Langmaoshan reservoirs all met the Class III standards of the Surface Water Environmental Quality Standards (GB3838－2002) and Yuqing, Jinxiuchuan and Laogmaoshan Reservoirs met Class II standards.

Table IV-6: Summary of Water Quality in Compliance with Functional Zoning for Surface Waters, Jinan City, 2017.

Water Body	Section	Applicable Standards	Compliance Status	Actual Water Quality Category	Exceedance parameter
Queshan Reservoir	Inlet	Drinking water source protected area (Class III)	Yes	Class III	NA
	outlet		Yes	Class II	NA
Yuqing Reservoir	Inlet and outlet	Drinking water source protected area (Class III)	Yes	Class II	NA
Jinxiuchuan Reservoir	Inlet and outlet	Drinking water source protected area (Class III)	Yes	Class II	NA
Wohushan Reservoir	Inlet and outlet	Drinking water source protected area (Class III)	Yes	Class III	NA
Langmaoshan Reservoir	Inlet and outlet	Drinking water source protected area (Class III)	Yes	Class II	NA
Daming Lake	Lixiating, Wumingting, Huiboqiao	Non- human body direct contact with recreational water area (Class IV)	Yes	Class III	NA
Yellow River	Luokou	Drinking water source protected area (Class III)	Yes	Class II	NA
Tuhai River	Xiakou	Industrial water area (Class IV)	Yes	Class IV	COD, NH_3
	Shangqiao	Industrial water area (Class IV)	Yes	Class IV	NH_3

	Shenqiao	Industrial water area (Class IV)	Yes	NA	NA
	Shenqiao	Provincial control assessment section on transboundary rivers	Yes	NA	NA
Main stream of Xiaoqing River	Mulizhuang	Water source protected area (Class III)	Yes	Class III	NA
	Huanxiangdian	Agriculture (Class V)	No	Worse than Class V	NH_3 and TP
	Damatou	Agriculture (Class V)	No	Worse than Class V	NH_3 and TP
	Xinfengzhuang	Agriculture (Class V)	No	Worse than Class V	NH_3 and TP
	Xinfengzhuang	Provincial control assessment section on transboundary rivers	No	NA	NH_3
Branches of Xiaoqing River	Luo River	Class V	Yes	Class IV	NA
	Xiahouqiao	Provincial control assessment section on transboundary rivers	Yes	NA	NA
	Zhangqigou	Class V	Yes	Class IV	NA
	Wanghudong Village	Provincial control assessment section on transboundary rivers	Yes	NA	NA

Source: Jinan Environmental Quality Bulletin (2017).

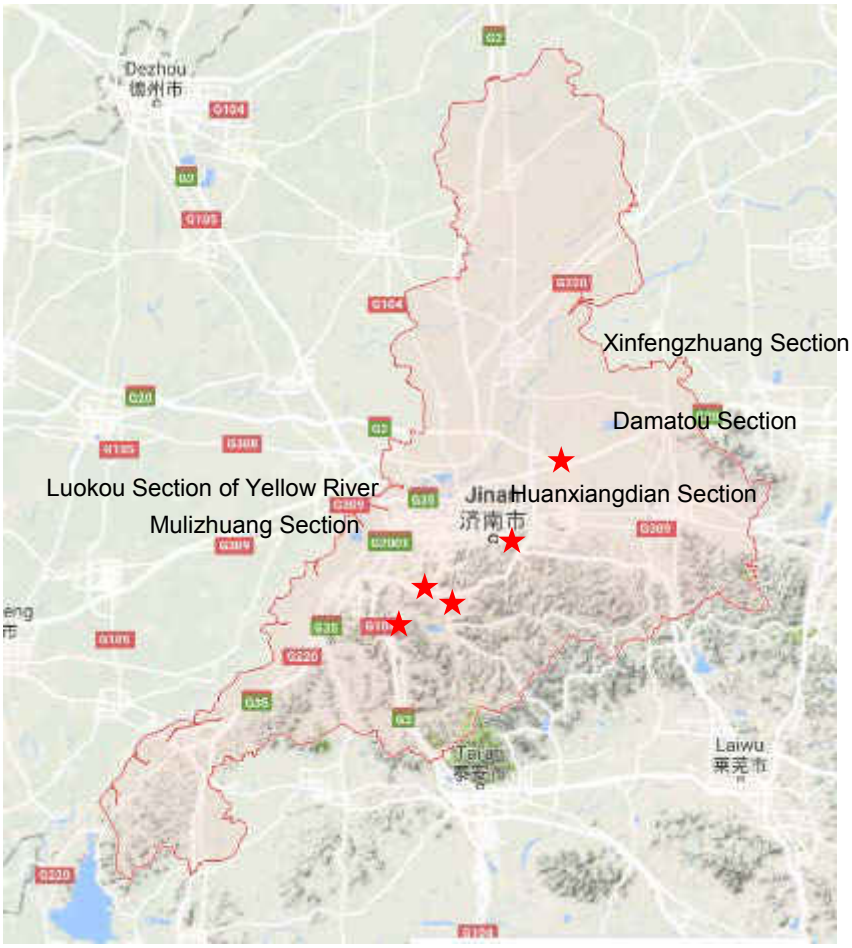
156. Based on site visit, the surface water body near the component site is Xiaoqing River (0.25 km away from No.25 community) and Yellow River (1.0 km away from No. 27 community) (**Figure IV-7**).There is no small local pond or drains in a radius of 500m near component site. Four sections of Xiaoqing River are monitored. Based on Jinan Environmental Quality Bulletin (2017), water quality of Xiaoqing River and Yellow River in Jinan is presented below:

157. In 2017, Luokou section of Yellow River is monitored on a monthly basis for 31 parameters. All parameters can meet class III standard.

158. In 2017, annual average concentrations of COD and NH_3-N in Mulizhuang Section (entry section) were 8 mg/L and 0.49 mg/L respectively. Compared to 2016, COD is decreased by 35.0%and NH_3-N is decreased by 3.9%.

159. In 2017, annual average concentrations of COD and NH_3-N in Xingfengzhuang Section (exit section) were 19 mg/L and 2.95 mg/L respectively. Compared to 2016, COD is decreased by11.2% and NH_3-N is decreased by 30.9%.

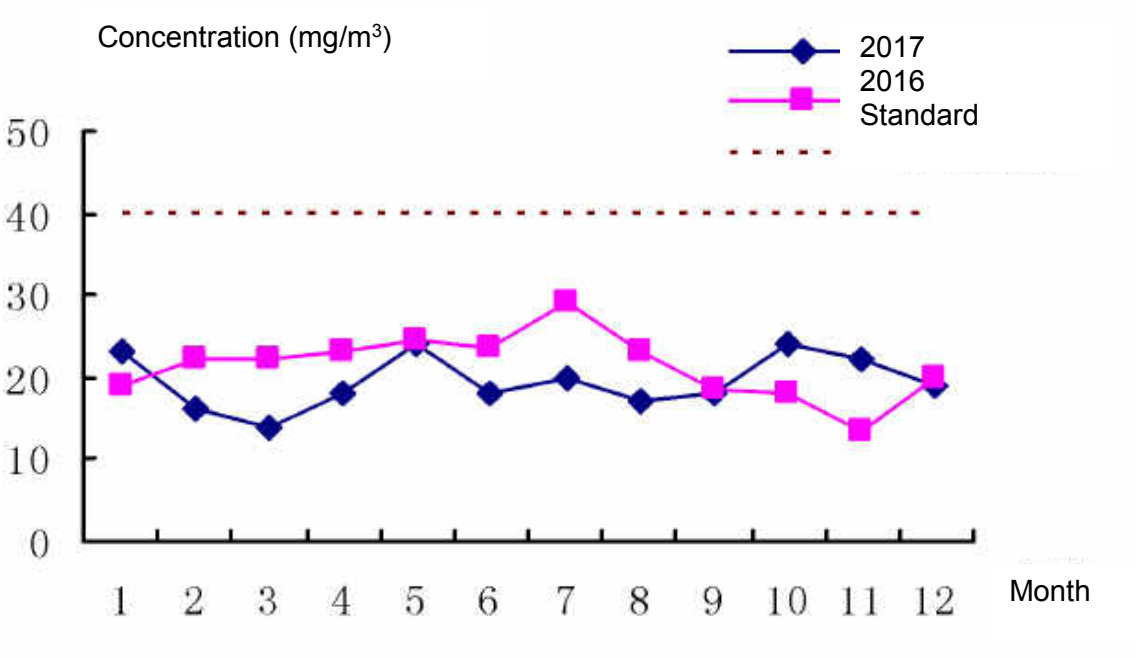
Figure IV-17: Monitoring sections of Xiaoqing River and Yellow River in Jinan.



Source: Jinan Environmental Quality Bulletin (2017).

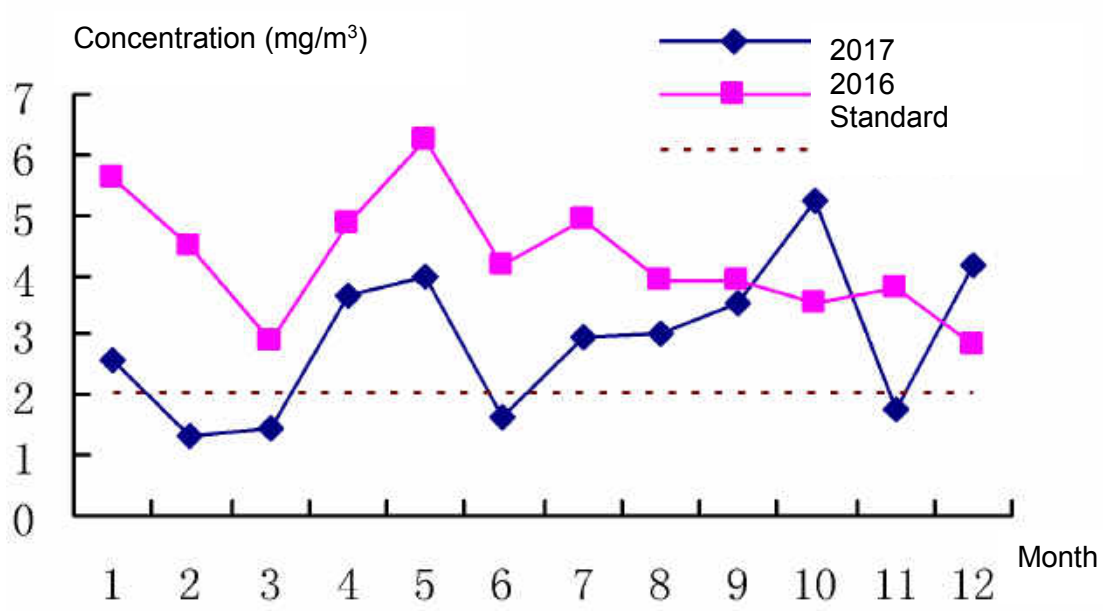
160. In 2017, monthly average concentration range of COD and NH_3-N in Xingfengzhuang Section (exit section) were 14-24 mg/L and 1.34-5.24 mg/L respectively (**Figure IV-18** and **Figure IV-19**). NH_3-N did not comply with standards.

Figure IV-18: Monthly average COD concentrations of Xingfengzhuang Section.



Source: Jinan Environmental Quality Bulletin (2017).

Figure IV-19: Monthly average NH3-N concentrations of Xingfengzhuang Section.



Source: Jinan Environmental Quality Bulletin (2017).

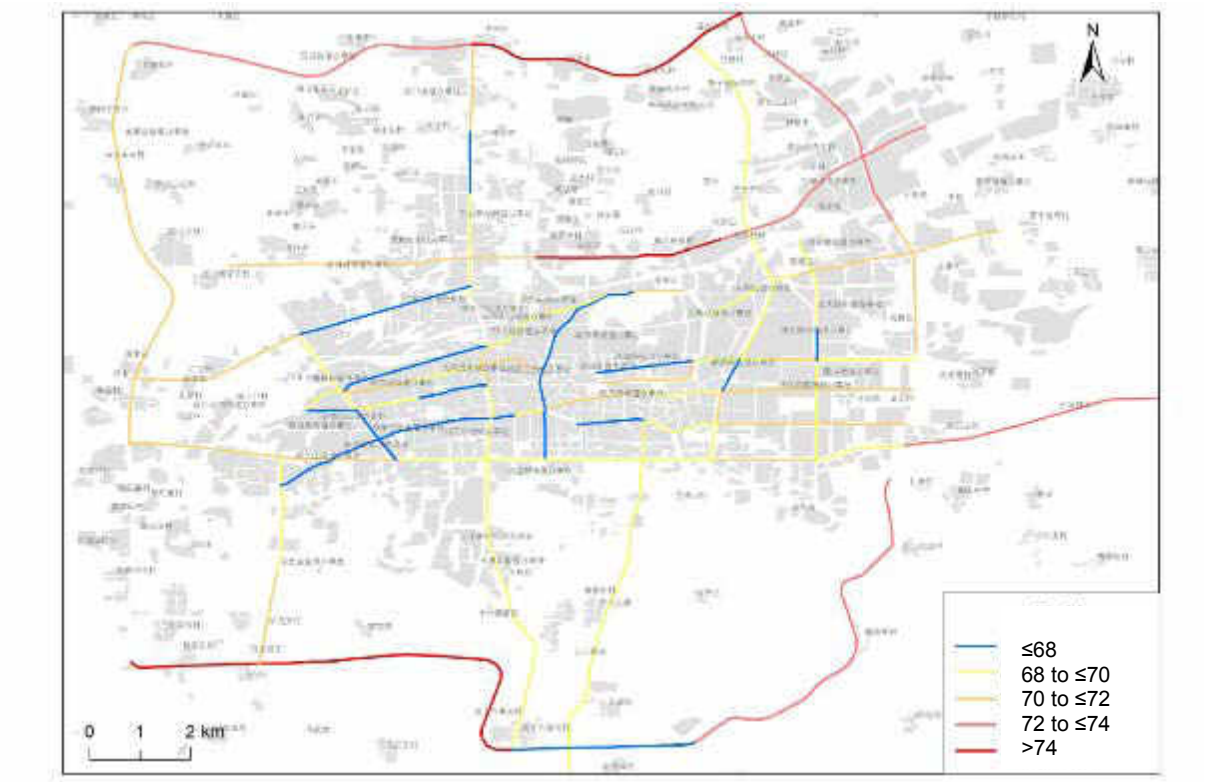
5. Noise

161. **Urban noise.** There were 214 urban noise monitoring sites in Jinan in 2017. The annual average 12-hour daytime noise level in 2017 was 53.7 dB(A), which complies with the Class I

standard of Environmental Quality Standard for Noise (GB3096－2008). Based on noise source analysis, 69.6% is domestic noise, 24.3% is traffic noise, 3.8% is industrial noise and 2.3% is building noise.

162. **Traffic noise.** Traffic noise in Jinan is monitored on 95 road sections of 39 urban trunk roads totaling 166.6 km in length. The results show that the overall average daytime traffic noise is 69.7 dB(A) which marginally complies with the Class 4a standard of Environmental Quality Standard for Noise (GB3096－2008) of 70 dB(A), applicable to urban trunk roads. Compared with 2016 the traffic noise level has decreased by 0.1 dB(A). Of the 39 urban trunk roads, 21 (53.8%) comply with the Class 4a standard (**Figure IV-20**).

Figure IV-20: Results of Traffic Noise Monitoring in Jinan, 2017.



Source: Jinan Environmental Quality Bulletin (2017).

E. Ecology and Sensitive Resources

163. **Ecology.** Jinan City (the full extent of the administrative boundary, including 6 districts and 4 counties or county level cities) is home to a reported 1,175 plant species in 149 families. This includes 12 families and 18 species of fern; 7 families and 21 species of gymnosperm; 106 families and 870 species of dicotyledon; and 24 families and 266 species of monocotyledon. There are 382 known species of wild plants, accounting for 33% of the total number of plant species; and 793 species of cultivated plants, accounting for 67% of the total. The fauna resources of Jinan include wild terrestrial and aquatic species typically associated with Yellow River watershed.

164. Natural vegetation is sparse and concentrated in the southern and eastern mountain area.

In the vast loess hilly area, the forest coverage rate is lower. Shrub and grass coverage are poor. Dominant flora within the component area is natural and artificial secondary vegetation being repeatedly destruction. Also, there are some artificial afforestation such as Pinus tabulaeformis, Platycladus orientalis, Robinia pseudoacacia, elm, poplar, and walnut, apple, hawthorn, persimmon and other economic forest.

165. The component is located in highly developed residential area, and there are no known ecological and/or sensitive resources in or near the component site. Land acquisition was completed 4 years ago.

166. The pipeline of the component will be installed in existing road with little or no vegetation cover (**Figure IV-21**). Original vegetation cover has been previously removed when the road was constructed and recovered with green belts along the roads. The pipeline will be constructed along the boundaries of the roads and avoid the existing green belts.

Figure IV-21: Surroundings of the pipeline

(i) Jiwei Road

(ii) South Erhuan Road West Extension

(iii) Shungeng Road

(iv) Wolong Road

(v) Wenzhuang Road

(vi) Dangyang Road

(vii) Fenshuiling Road

(viii) S103 Road

(ix) Weifang Road

(x) Jiuqu Road

167. Based on the domestic EIA, site surveys and records review, there are no known rare or endangered flora or fauna, species with international, national or provincial protection status, areas of natural or critical habitat,[11] parks, nature reserves, or areas with special national, regional or local ecological significance within or adjacent to any of the component site. There are also no known drinking water sources, scenic sites based on both sites surveys and a review of relevant literature, sites with Physical Cultural Resources (PCRs).[12]

[11] Natural habitat is land and water areas where the biological communities are formed largely by native plant and animal species, and where human activity has not essentially modified the area's primary ecological functions. Critical habitat are areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic, or cultural importance to local communities (Environment Safeguards: A Good Practice Sourcebook, ADB, 2012).

[12] PCRs are broadly defined as covering all types of tangible cultural heritage, including movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic or other cultural significance. PCR are human-made objects, natural features, or a mix of the two. They may be located in urban or rural areas and may be above or below ground or underwater. They may be known and listed on official inventories, but often they are undiscovered (Environment Safeguards: A Good Practice Sourcebook, ADB, 2012).

168. **Sensitive receptors.** The domestic EIA report identifies 9 sensitive receptors for air and noise impacts near the pipeline route during construction phase. (**Table IV-7**). And the 29 communities (**Table III-3**) are the sensitive receptors during construction phase and operation phase.

Table IV-7: Sensitive receptors near the pipeline.

No.	Road name	Sensitive receptors	Direction	Distance (m)
1	South Erhuan Road West Extension	Jingjia Community	N	320
		Ziming Community	N	900
		Jinan University	N	250
		Xingyuan Jiaju	N	100
		Yangzhuang Primary School	N	350
2	Dangyang Road	Ziming Shanzhuang	E	75
		Majiazhuang Village	W	50
		Tugou Village	E	60
		Government of Huaiyin District	E	550
3	Qilu avenue	Jinke City	E	45
		Waihai Garden	E	400
		Dayang Village	E	150
4	Wolong Road	Rongxiuyuan	N	80
		Wangguanzhuang	S	50
		Wenyuan	S	35
		Qingchengju	N	45
		Baju	N	55
5	Jiwei Road	Wangguanzhuang	W	50
		Jiahexinyuan	E	100
		Jinanlvyuan	W	80
		Jier Nanyuan	W	65
6	Jingliu Road	Huaijiecun	S	50
		Jinan No.5 Hospital	N	150

7	Liuchangshan Road	Yangguang 100	N	45
		Shiji Jiayuan	S	150
8	Jingyi Road	Jingwei Jiayuan	N	46
		Jinan No.2 Hospital	S	66
		Shunxiang	S	52
9	Yangguangxin Road	Quanjingtianruan	W and E	50
		Rongsheng Yuan	E	72
		Ruyi Yuan	E	45
		Huitong Garden	E	64
		Yangguang 100	W	33
		Yixin Yuan	E	50
10	Xishilihe Street	Dingzishan	NE	72
		Rongxiu Yuan	SW	120
		Yangguang 100	NE	43
11	Tiancheng Road	Jinan Tianqiao Hospital	E	52
		Guanzhaying	W	40
		Tiancheng Road Primary School	E	162
12	Yingshi Street	Rongkai Yuan	W	120
		Huaiyuan Xincheng	W	45
		Jinan No.5 Hospital	E	200
13	West Minghu Road	Maoxin Xinqu	N	63
		Beiliu Xinqu	S	30
		Faxiang Fudi	S	55
		Jinan No.15 middle school	N	120
		Jian Xinqu	S	57
		Beitan	S	42
		Bali Garden	N	46
		Daming Lake	SE	130

14	South Xinerhuan Road	Lvdi City	S	112
		Yongjing Jun	S	248
15	East Wenzhuang Road	Tielu Nanyuan	W	203
		Nankang Xinju	W	150
		Xinglong Jiayuan	E	83
16	Jiuqu Road	Yulong Xiaoqu	N	168
		Huarun Ziyun	N	220
17	Fengshuiling Road	Luneng Garden	N	180
18	S103 Road	Ronghui Aidu	E	60
		Lvdi Aicheng	W	120
19	South Erhuan Road	Luneng Lingxiu City	S	64
		Yinfeng Garden	N	48
		Yuexiu Yuan	N	78
		Jinan Asthma Hospital	N	181
20	Shungeng Road	Jiuxiu Yuan	E	50
		Yuhan	W	155
		Hefeng Yuan	W	240
		Yinfeng Shanzhuang	W	90
21	South Erqixincun Road	Shiji Jiayuan	N	130
		Qianxi Jiayuan	S	50
		Erqi Tielu	N	40
22	North Beiguan Road	Baihe	E	53
		Rongji Jiayuan	W	80
23	Dikou Road	Tianqiao District Government	N	80
		Jinan No.11 School	N	120
		Junxiu Garden	N	80
		Qilu Garden	S	55
		Wansheng Yuan	S	65

169. Sensitive receptors are given special attention in the assessment of impacts (Section V) and the EMP (Appendix I). The boilers will be over 12 meters from the residential buildings following the PRC standards.

F. Socio-economic and Cultural Resources

170. **Jinan city**. Jinan City is comprised of 6 districts (Lixia, Shizhong, Huaiyin, Tianqiao, Licheng and Changqing); 3 counties (Pingyin, Jiyang, and Shanghe); and a county level city (Zhangqiu) (**Figure IV-22**). The city has a total area of 8,177 km^2,

171. Total population was 6,328,300 by the end of 2017 (**Table IV-8**).

172. There are 49 ethnicities in Jinan including Hui, Mongolian and Manchu. However, the ethnic minorities only account for 1.84% of the total population while the rest is Han ethnicity. There are no ethnic groups in the component areas, therefore, the component will not have impacts on them.

173. **Economy.** Jinan is the political, economic, cultural, scientific, educational, and financial center of the province, and has been designated with sub-provincial administrative status since 1994.

Figure IV-22: Map of Jinan City administrative divisions

Source: https://en.wikipedia.org/wiki/Jinan

Table IV-8: Data on Jinan City administrative divisions

Subdivision	Land Area (km^2)	Population (2016)	Population Density (persons/km^2)
Lixia District	100.87	627,400	6220
Shizhong	280.33	617,600	2203
Huaiyin	151.56	409,900	2705
Tianqiao	258.71	516,700	1997
Licheng	1303.88	971,800	745
Changqing	1208.54	559,800	463
Zhangqiu	1721.29	1,029,700	598
Pingyin	715.18	374,700	524
Jiyang	1097.15	578,100	527
Shanghe	1163.19	641,400	551

Source: Jinan Statistical Bureau, 2017

174. In 2017, the city's GDP was CNY 720.196 billion, of which the primary sector accounted for 4.4% or CNY 31.740 billion; the secondary sector accounted for 35.7% or CNY 256.922 billion; and the tertiary sector accounted for 59.9% or CNY 431.534 billion.

175. **Employment.** Jinan's employed population was 3.887 million in 2017, including 718,000 employees in primary industry, 1.247 million in secondary industry, and 1.922 million in tertiary industry, giving an employment ratio for the three industries of 18.5%: 32.1%: 49.5%. In 2015, the registered unemployment rate was 2.0%.

176. **Education.** Jinan had 42 institutions of higher education in 2017, and 544,400 students. Of these, 10 institutions are privately operated with 93,000 students. There are 305,600 students in middle schools and 446,600 students in primary schools.

177. **Public transit and traffic conditions.** The number of vehicles on the roads of Jinan is increasing dramatically. In 2017, 241,000 new vehicles were added, and total vehicle ownership reached 2.065 million vehicles, of which car ownership was 1.95 million, an increase of 11.9%. Private cars were used an average of 2.9 times per day.

178. Jinan has a well-developed railway, highway and aviation transportation network, and has become an important hub connecting with eastern, northern, central and western regions of the PRC.

179. Jinan is one of the 45 national arterial hubs of the highway network. Jinan's own highway network is highly developed with multiple national highways, including highway 104, 305, 309, 220, Jiqing Expressway and Jingfu Expressway, and provincial highways running through it. Currently a half-day travel circle is being established with Jinan in the center and connections to all cities within the province.

180. Jinan is on the Beijing-Shanghai Railway and Jiaozhou-Jinan Railway; Jinan-Handan Railway is connected with Beijing-Kowloon Railway and Beijing-Guangzhou Railway (two major trunk railways). The Beijing-Shanghai high speed railway has already been in operation for many years.

181. **Wastewater treatment and solid waste management**. The Jinan urban area has five urban wastewater treatment plants (WWTPs) and 11 smaller domestic wastewater treatment stations, with a total capacity of 0.84 million m^3/d. They are served by a pipeline network including 1,300 km of sewers, 950 km of storm water lines, and 20 pump stations (Jinan Municipal Utilities Bureau, 2017). According to 2016 and 2017 JEPB monitoring data, the effluent of all the 16 WWTPs and stations is in compliance with applicable standards.

182. In 2017, the urban area of Jinan handled 1,858,000 tons of domestic solid waste, of which 844,500 tons was incinerated and 613,500 tons was landfilled (Information on Environmental Pollution Prevention and Control of Solid Waste, JEPB). Solid waste and hazardous waste generated from the component will be treated at existing certificated facilities following PRC regulations.

183. **Physical Cultural Resources** Jinan is an accredited famous historic and cultural city for its long-standing history and culture unique natural landscape. Historic sites include Chengziya Longshan Culture Site, Guo's Ancestral Temple of Han Dynasty at Xiaotangshan, Four Gates Pagoda of Sui Dynasty, Dragon and Tiger Pagoda of Tang Dynasty, Nine Tops Tower and Luozhuang Han Tomb.

184. Jinan has a rich history. However, the component activities are all on long developed sites within highly developed and modified environment. There are no known PCRs in component site or in a radius of 500 m from the component site and within the airshed that could be affected by the component.

V. ANTICIPATED IMPACTS AND MITIGATION MEASURES

185. Anticipated positive and negative environmental impacts of the proposed component were assessed based on the domestic FSR, domestic EIA, a technical due diligence review of the FSR undertaken by ADB PPTA specialists, public consultations led by the IA and assisted by ADB PPTA consultants and site visits, surveys and consultations undertaken by ADB PPTA consultants.

186. Pre-construction, construction and operation phases were considered separately. The results of the assessment indicate that during the pre-construction phase environmental issues are very limited and are mostly associated with ensuring appropriate incorporation of mitigation measures into the component design.

187. Potential negative environmental impacts during the construction phase are short-term and localized, and are associated with construction noise, fugitive dust, solid waste, wastewater, disruption of traffic and community services, and risks to worker health and safety. Potential negative operation phase impacts are associated with boiler emissions, waste and wastewater, noise, and health and safety risks to workers and community.

188. Potential positive operation phase impacts are significant and long-term and are associated with emissions reductions compared to equivalent heat production from coal-fired boilers.

A. Pre-Construction Phase Measures to be Implemented During Detailed Design

1. Siting and Land Acquisition

189. The component will not entail any permanent or temporary physical displacement or economic displacement. This is because:

(i) The boilers rooms will be built by the developers following the PRC standards. And the heat pumps will be installed at reserved land for heating in the communities. Land acquisition of the communities have been done by the developers.
(ii) The pipeline will be installed at the boundaries of the existing roads.

190. Overall, the component will not result in any involuntary land acquisition, resettlement or physical displacement. There will be no loss of personal property, structures, crops, trees or other assets. There are also no potential adverse impacts on disadvantaged or vulnerable groups, including the poor, women and children, and Indigenous Peoples.

2. Mitigation Measures and Monitoring during Detailed Design

191. Mitigation measures to be adopted during detailed design to minimize the impacts are as follows:

(i) **Detailed Design.** Environmental mitigation and pollution control measures indicated in this IEE, the EMP and the domestic EIA will be incorporated into the detailed design.

(ii) **Organization.** A PMO will be established and an external Loan Implementation Environmental Consultant (LIEC) will be hired by the IA.

(iii) **Institutional strengthening**: Prior to the start of construction, the institutional strengthening and training program will be delivered by the LIEC. The training will focus on ADB's and PRC's relevant environmental, health and safety laws, regulations and policies; implementation of the EMP, environmental monitoring, chance find procedures for PCRs, and the GRM. Training will be provided to the IA, relevant PMO staff, and contractors.

(iv) **Bidding Documents and Contracts.** Environmental mitigation measures indicated in this IEE, the EMP and the domestic EIA will be included in contracts for civil works and equipment installations. All contractors will be required to strictly comply with the EMP.

(v) **Environmental monitoring.** The environmental monitoring program (EMoP, see **Table 3** in **Appendix I**) will be incorporated into the design to ensure that environmental impacts are closely monitored and activities of the component construction and operation are closely supervised against the PRC environmental laws, regulations and standards, ADB SPS, EMP and the approved domestic EIA.

3. Grievance Redress Mechanism

192. In accordance with the GRM presented in Chapter VIII of the IEE, a staff member from IA will be assigned to be overall responsible for the GRM; GRM training will be provided for PMO, IA and GRM access points; and the GRM access point phone numbers, fax numbers, addresses and emails will be disclosed to the public at the construction site and Energy Centers and HESs.

4. Training and Capacity Building

193. An institutional strengthening and training program will be delivered by LIEC (see **Table 4** in **Appendix I**). The training will focus on ADB's and PRC's environmental, health and safety laws, regulations and policies; implementation of the EMP, EMoP, the GRM and international good EHS practices. Training will be provided to the IA, relevant staff and contractors and the construction supervision company.

5. Permitting

194. All necessary construction permits will be obtained from the relevant authorities.

B. Anticipated Environmental Impacts and Mitigation Measures during Construction Phase

195. Potential impacts during the construction phase could include air pollution, noise, water pollution, solid waste, poor occupational health and safety practices, and community health and safety. Potential air quality impacts could occur due to fugitive dust generated at construction sites from stockpiles of uncovered earth materials, and vehicles hauling materials. The use of powered mechanical equipment (PME) during construction activities will generate noise. Construction activities will generate process wastewater and construction workers will produce wastewater. Wastewater generation is expected to be limited considering the nature and scale of construction. Construction works will produce construction waste. Workers will face occupational health and safety issues working on construction sites. Potential impacts are assessed and addressed below. Identified impacts can be readily addressed through the application of good construction site

practices.

1. Impacts to Flora and Fauna

196. Typical construction impacts on flora and fauna include removal of vegetation and disruption of the ecosystem during construction. If present, rare or endangered flora or fauna may also be impacted. However, the component construction site is located in residential environments or existing roads with little or no vegetation cover other than recently established grasses and shrubs. It is therefore unlikely that there will be direct impacts on natural lands or ecological values from component site developments.

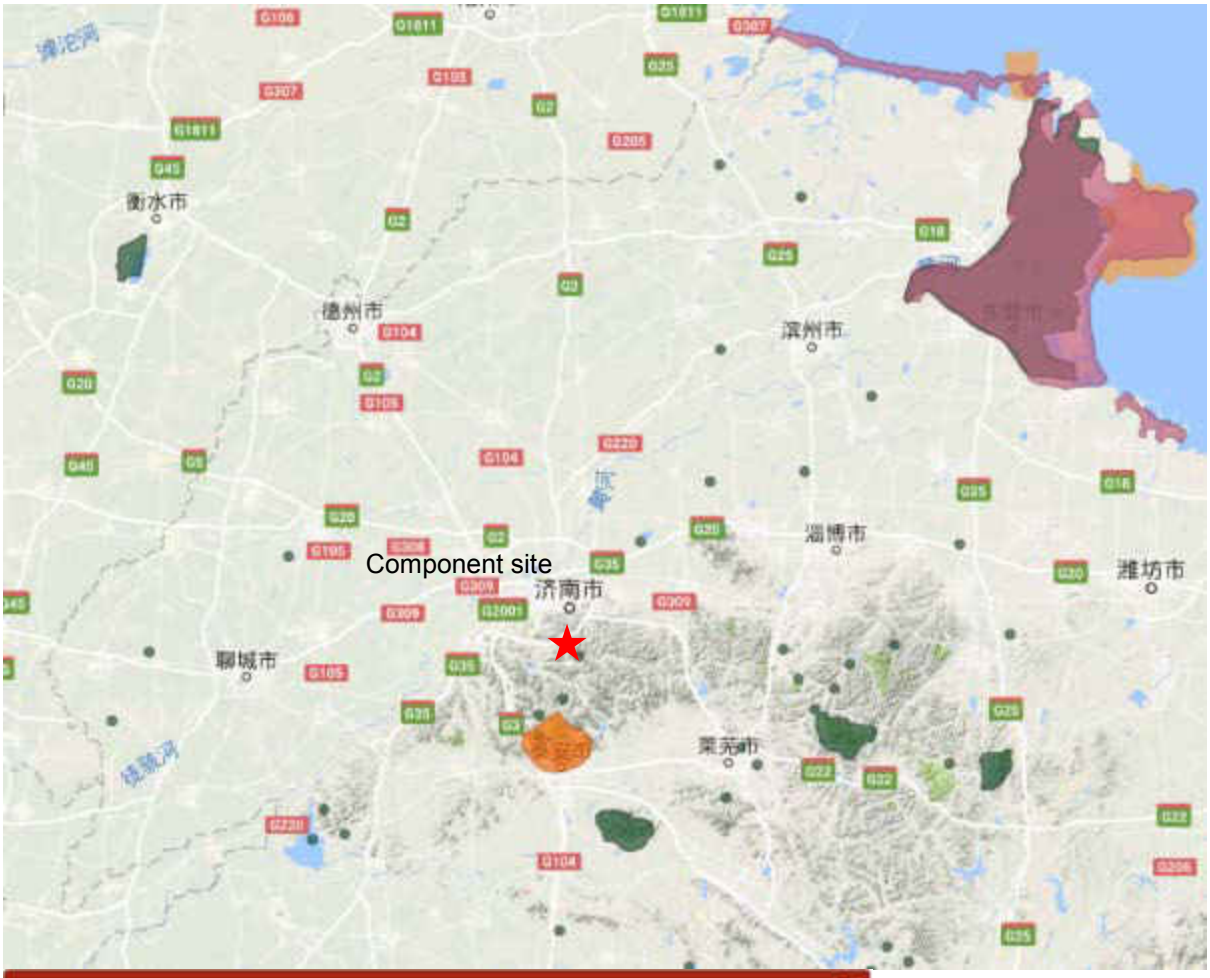
197. The locations of component site have been reviewed against provincial records provided by the IBAT[13] maps of Shandong protected areas and Important Bird and Biodiversity Areas (IBBAs). No component encroaches on any legally protected natural area or other critical habitats.

198. Based on site visits, there is no known rare or endangered flora or fauna, parks, nature reserves or areas with special ecological significance which will be impacted by the component. Impacts on flora or fauna are thus expected to be minimal and short-term. Nonetheless, to address potential impacts, a greening plan will be implemented. Site vegetation plans will be developed at component site using appropriate local native species. Any existing greening areas impacted by the component will be restored post-construction using appropriate native species.

199. During construction, construction working areas will be demarcated to prevent encroachment and damage to adjacent areas.

[13] International Biodiversity Assessment Tool. https://www.ibat-alliance.org/ibat-conservation/

Figure V-1: IBAT Habitat Areas and Component location.



2. Erosion and Spoil

200. Construction activities such as excavation and filling activities for pipeline installation may lead to surface erosion. The most vulnerable soil erosion areas in the construction site include excavation sites, leveling sites, spoil sites, temporary construction sites, and other areas where surface soil is disturbed. Soil erosion can also be more serious on slopes or near water bodies, though based on site visits all construction sites are generally flat and there are no rivers, streams, ditches or lakes that are likely to be affected. Soil erosion can also occur after the completion of construction if site restoration is inadequate. Pipeline excavation and burial may also cause localized erosion and mudding of adjacent road. Finally, construction activities may generate surplus spoil.

201. These impacts can be mitigated through typical good construction practice as set out in EHS Guidelines on Construction and Decommissioning (C&D), erosion controls and site maintenance:

(i) At construction site, the potential for storm water runoff will be assessed and appropriate storm water drainage systems to minimize soil erosion will be implemented, including perimeter bunds and establishment of temporary detention and settling ponds to control topsoil runoff.

(ii) Land excavation and filling will be balanced so as minimize the requirement for fill material transportation.

(iii) During earthworks, the area of soil exposed to potential erosion at any time will be minimized through good project and construction management practices.

(iv) Temporary spoil storage sites (and storage containers at lane modification and stations construction sites) will be identified, designed, and operated to minimize impacts. Spoil sites will be restored at the conclusion of storage activities.

(v) Spoil will be reused on-site to the maximum extent feasible as fill. Excess spoil that cannot be used on-site will be transported to an approved spoil disposal site.

(vi) Spoil and aggregate piles will be covered with landscape material and/or regularly watered.

(vii) Waste construction material such as residual concrete, asphalt, etc., will be properly handled for reuse or disposal.

(viii) Construction and material handling activities will be limited or halted during periods of rains and high winds.

(ix) Pipelines will be installed and backfilled in a sequenced section-by-section approach. Open excavation areas during trenching activities will be minimized, and appropriate construction compaction techniques utilized.

(x) Any planned paving or vegetating of areas will be done as soon as practical after the materials are removed to protect and stabilize the soil.

(xi) Once construction is complete disturbed surfaces will be properly sloped and revegetated with native trees and grass (see greening plan).

3. Wastewater

202. Inappropriate disposal of domestic wastewater (from construction workers) or construction wastewater (from drainage of washing construction equipment and vehicles, and oil-containing wastewater from machinery repairs) may cause soil or groundwater resources contamination.

203. Construction wastewater will be produced from the maintenance and cleaning of mechanical equipment and vehicles, wastewater from pipeline cleaning and equipment cleaning. It is unlikely that runoff from site will reach distant water bodies, however to guard against runoff and infiltration impacting the immediately surrounding areas, the contractors shall ensure that runoff from site will not reach distant water bodies.

204. Inappropriate disposal of construction wastewater (from construction site runoff, washing construction equipment and vehicles, and oil-containing wastewater from machinery repairs) could potentially pollute nearby water bodies and clog local drains. Workers will generate but limited amount of domestic wastewater.

205. To prevent pollution of water resources, the following mitigation measures and construction good practice as set out in EHS Guidelines on C&D, will be implemented:

(i) Existing toilets at the component site will be provided for the workers.

(ii) Construction wastewater generated during construction phase will be discharged to the municipal sewer system. All discharged construction wastewater will meet the appropriate PRC standard GB/T 31962-2015 prior to discharge. Discharged water will then be treated in the nearby WWTP.

(iii) All necessary measures will be undertaken to prevent construction materials and waste from entering drainage system.

(iv) Maintenance of construction equipment and vehicles will not be allowed on sites to reduce wastewater generation.

(v) All construction machinery is repaired and washed at special repairing shops. No on-site machine repair, maintenance and washing shall be allowed so as to reduce wastewater generation;

(vi) Storage facilities for fuels, oil, and other hazardous materials are within secured areas on impermeable surfaces with 110% volume of the materials stored, and provided with bunds and cleanup kits;

(vii) The contractors' fuel suppliers are properly licensed, follow proper protocol for transferring fuel, and are in compliance with Transportation, Loading and Unloading of Dangerous or Harmful Goods (JT 3145-88).

4. Air Pollution

206. Fugitive emission of dust (measured as TSP) during earthworks and fumes from asphalting and concrete batching off-site are expected to be the main air pollutants during the construction stage. The PRC Shandong Province's integrated particulate matter emission standard for stationary sources in Shandong Province (DB 37/1996-2011) establishes standards for the emission of air pollutants from these activities.

207. Fugitive dust will be generated on construction sites during earthworks of the pipelines

from construction activities, uncovered earth material stockpiles on construction sites and temporary spoil storage and disposal areas (and containers), and from vehicles hauling loads, especially if loads are uncovered. Impacts will be short-term and localized, and in line with typical construction works that occur daily in cities throughout the PRC and the world. The pipelines will be constructed in trenches with each trench (100 meters) taking about two weeks.

208. Anticipated sources of air pollution from construction activities include: (i) dust generated from loading, hauling and unloading; (ii) dust generated from disturbed and uncovered construction areas, especially on windy days; (iii) dust generated by the movement of vehicles and heavy machinery on unpaved access and haul roads; (vi) emissions from construction vehicles (gaseous CO and NO_2) and heavy diesel machinery and equipment.

209. Without appropriate mitigations, construction phase activities may generate significant localized total suspended particulate (TSP)[14] levels, with worst case conditions occurring in clear weather without watering. Based on previous domestic experience of similar projects, predicted TSP concentrations in clear weather conditions without watering are presented in **Table V-1.** Dust impacts from pipelines will be more limited in scope, and are expected to be within approximately a 20 m radius of both sides of the roads

Table V-1: Predicted TSP concentrations, clear weather without mitigations.

Construction Activity	Dust Sources	Wind speed (m/s)	Distance (m)	Concentration (mg/m^3)
Earthworks	Excavation, backfilling, loading and unloading, transportation, site operation	2.4	50	11.7
			100	8.8
			150	5.0

210. To reduce air quality impacts during the construction period, the following air quality management measure and construction good practice as set out in EHS Guidelines on C&D will be implemented:

(i) Water will be sprayed on active construction sites including where fugitive dust is being generated on a daily basis, and more frequently during windy days.

(ii) Transport vehicles will be limited to low speeds in construction sites.

(iii) Loads will be covered during truck transportation to avoid spillage or fugitive dust generation. Fine materials will be transported in fully contained trucks.

(iv) Construction site roads will be well maintained and watered and swept on an as-needed basis. Construction site road entry points will be equipped with truck drive through wash ponds.

(v) Transport routes and delivery schedules will be planned to avoid densely populated and sensitive areas, and high traffic times.

(vi) Store petroleum or other harmful materials in appropriate places and cover to minimize fugitive dust and emission.

14 Airborne particles or aerosols that are less than 100 micrometers are collectively referred to as total suspended particulate matter (TSP).

(vii) Provide regular maintenance to vehicles in order to limit gaseous emissions (to be done off-site).

(viii) Temporary fencing will be erected around pipeline installation activities.

(ix) Construction spoil and other construction materials will be temporary stored using containers, but they may the potential to generate dust. Thus, containers will be covered and/or watered if necessary.

(x) Muddy or dusty materials on public roads outside the exits of works areas will be cleaned immediately.

(xi) On-site asphalting and concrete batching is prohibited.

(xii) Disturbed site will be revegetated as soon as possible after the completion of pipeline installation.

211. Overall, air quality impacts from construction activities will be short-term (because of the phased construction approach), localized and low in magnitude, and are in line with typical construction or road works undertaken daily in cities throughout the PRC and around the world.

5. Noise Impacts

212. During the construction phase noise and vibration will be generated by on site construction activities using heavy equipment and by the transport of construction materials and equipment. Noise source during construction phase is considered a point noise source, and the predictive model is as follows:

$$L_i = L_0 - 20\lg\frac{R_i}{R_0} - \Delta L$$

Where, L_i and L_0 are equipment noise sound levels at R_i and $R_{0,}$ respectively, ΔL is additional decrement produced by barriers, vegetation and air.

213. For the impact of multiple construction machines on a location, sound level superposition uses the following formula:

$$L = 10\lg\Sigma 10^{0.1\times L_i}$$

214. The component will install fence at the site boundaries which can reduce the noise by 10 dB. A significant increase in localized noise is expected during construction. Noise will be from construction activities including equipment unload and installation and other heavy machinery, as well as noise from goods and material transportation. The major anticipated noise sources at each construction stage are presented in **Table V-2**. Though noise levels may be high, the impacts will be temporary and localized, and can be further mitigated. Construction activities will conducted during daytime and construction sites will be fenced to minimize noise impacts.

Table V-2: Primary noise sources at each construction phase.

Construction Phase	Name	Sound Level dB(A)	Distance from the source (m)	Noise level at the 100m away without fence	Noise level at the 100m away with fence	Directivity
Earthwork	Excavator	80-85	5	40-45	30-35	No
	Loader	85-90	5	45-50	35-40	No
	Bulldozer	85-90	3	45-50	35-40	No
	Dump truck	85-90	3	45-50	35-40	No
Equipment installation	Electrical drill	85-95	5	45-55	35-45	No
	Electrical hammer	90-95	5	50-55	4045	No
	Electrical saw	90-95	5	50-55		No
Transport Vehicle	Trailer	70-75	5	30-35	20-25	No
	Flat car	70-75	5	30-35	20-25	No
	Truck	70-75	5	30-35	20-25	No

Source: Domestic EIA.

215. To ensure construction activities meet PRC noise standards and to protect workers and adjacent residents, the following mitigation measures and construction good practice as set out in EHS Guidelines on C&D will be implemented:

(i) Construction activities will be planned in consultation with local authorities and communities so that activities with the greatest potential to generate noise and vibration are planned during periods of the day that will result in the least disturbance.

(ii) Construction activities, and particularly noisy ones, are to be limited to reasonable hours during the day and early evening. Construction activities will be strictly prohibited during the nighttime (22:00 h to 07:00 h). Exceptions will only be allowed in special cases, and only after getting approval of the surrounding residents, local EPB and other relevant departments. And nearby residents should be notified of such night time activities well in advance.

(iii) When undertaking construction planning, simultaneous high-noise activities will be avoided, and high noise activities will be scheduled during the day rather than evening hours. Similarly, construction site will be planned to avoid multiple high noise activities or equipment from operating at the same location.

(iv) Low-noise equipment will be selected as much as possible. Equipment and machinery will be equipped with mufflers and will be properly maintained to minimize noise.

(v) Noise PPE will be provided to workers to meet the requirements in occupational exposure limits for hazardous agents in work place Part 2: physical agents (GBZ 2.2-2007) and EHS Guidelines.

(vi) Transportation routes and delivery schedules will be planned during detailed design to avoid densely populated and sensitive areas and high traffic times.

(vii) Vehicles transporting construction materials or waste will slow down and not use their horn when passing through or nearby sensitive locations, such as residential communities, schools and hospitals.

(viii) Special attention will be paid to protect sensitive sites near the component site: high noise construction activities will be positioned as far away from sensitive sites as possible.

(ix) Noise from cleaning of heating pipelines will be minimized by utilization of low noise valves, mufflers after the valves and sound insulation on the external walls of pipelines.

6. Solid Waste

216. Solid waste generated in the construction phase will include construction and domestic waste. Construction wastes include various waste packing materials and waste generated during equipment and pipeline installation and cleaning. An estimated of 0.5 kg/day per worker of domestic waste will be generated from construction workers and maximum workers will be around 200. During the construction phase, about 35 tons domestic waste will be generated Inappropriate waste storage and disposal could affect soil, groundwater and surface water resources, and hence, public health and sanitation.

217. The following solid waste management measure and construction good practice as set out in EHS Guidelines on C&D will be implemented:

(i) Wastes will be reused or recycled to the extent possible.

(ii) Littering by workers will be prohibited.

(iii) Excavated soil will be backfilled onsite to the extent possible. Excess spoil that cannot be used on-site will be transported to an approved spoil disposal site.

(iv) Existing domestic waste containers will be used for domestic waste collection at component sites. Domestic waste will be collected on a regular basis by the local sanitation departments and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and requirements.

(v) Construction waste dumpsters will be provided at all construction sites. Construction waste will be collected on a regular basis by a licensed waste collection company and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and requirements.

(vi) There should be no final waste disposal on site. Waste incineration at or near the site is strictly prohibited.

(vii) Contractors will be held responsible for proper removal and disposal of any significant residual materials, wastes, spoil, waste from contaminated soils that remain on the site after construction.

7. Hazardous and Polluting Materials

218. Inappropriate transportation, storage, use and spills of petroleum products, refrigerant and hazardous materials such as oily waste can cause soil, surface and groundwater contamination. To prevent this, the following mitigation measures and construction good practice as set out in EHS Guidelines on C&D will be implemented:

(i) A hazardous material handling and disposal protocol that includes spill emergency response will be prepared and implemented by contractors.

(ii) Storage facilities for fuels, oil, chemicals and other hazardous materials will be within secured areas on impermeable surfaces provided with dikes with a 110% volume, and at least 300 m from drainage structures and important water bodies. A standalone site within the storage facility will be designated for hazardous wastes.

(iii) Signs will be placed at chemicals and hazardous materials storage sites to provide information on type and name of chemicals and hazardous materials.

(iv) Suppliers of chemicals and hazardous materials must hold proper licenses and follow all relevant protocols and PRC regulations and requirements.

(v) A licensed company will be hired to collect, transport, and dispose of hazardous materials in accordance with relevant PRC regulations and requirements.

8. Impacts on Community Health and Safety

219. Construction activities have the potential to cause community disturbance such as traffic congestion or delays, and public safety risks from heavy vehicles and machinery traffic and risk to kids trying to get onto construction site. Mitigations and construction good practice as set out in EHS Guidelines on C&D and EHS general guidelines will be implemented to address traffic and other community disturbance issues.

(i) Transportation routes and delivery schedules will be planned during detailed design to avoid densely populated and sensitive areas and high traffic times.

(ii) Vehicles transporting construction materials or wastes will slow down and not use their horn when passing through or nearby sensitive locations, such as residential communities, schools and hospitals.

(iii) Signs will be placed at construction sites in clear view of the public, warning people of potential dangers such as moving. All sites will be made secure, discouraging access by members of the public through appropriate fencing with security guards whenever appropriate.

9. Workers Occupational Health and Safety

220. Construction may cause physical hazards to workers from noise and vibration, dust, handling heavy materials and equipment, falling objects, work on slippery surfaces, fire hazards, chemical hazards such as toxic fumes and vapors, and others.

221. Contractors will implement adequate precautions to protect the health and safety of their workers:

(i) Each contractor will undertake H&S risk assessment of construction works and implement relevant construction phase EHS plan in line with construction good practice as set out in EHS Guidelines on C&D and Occupational H&S guidelines.

(ii) Identify and minimize the causes of potential hazards to workers. Implement appropriate safety measures.

(iii) Provide training to workers on occupational health and safety, emergency response, especially with respect to using potentially dangerous equipment and

storage, handling and disposal of hazardous waste. Induction will be conducted before construction and no worker is allowed on site without induction.

(iv) Ensure that all equipment is maintained in a safe operating condition.

(v) Provide appropriate PPE to workers.

(vi) Provide procedures for limiting exposure to high noise or high temperature working environments in compliance with PRC occupational exposure limits for hazardous agents in work place Part 2: physical agents (GBZ 2.2-2007).

(vii) Ensure regular safety meetings with staff.

10. Physical Culture Resources

222. Based on site visits there are no known cultural heritage or archaeological sites at or near the component sites. However, construction activities have the potential to disturb as yet unknown underground cultural relics. To address this issue, a construction phase chance find procedure will be established and activated if any chance finds of PCRs are encountered:

(i) construction activities will be immediately suspended if any PCRs are encountered;

(ii) destroying, damaging, defacing, or concealing PCRs will be strictly prohibited in accordance with PRC regulations;

(iii) local Cultural Heritage Bureau will be promptly informed and consulted; and,

(iv) construction activities will resume only after thorough investigation and with the permission of the local Cultural Heritage Bureau.

(v) In case of any PCR is found, ADB SPS 2009 requirements as well as PRC laws and regulations will be followed.

C. Anticipated Operation Phase Impacts and Mitigation Measures

223. The component may cause some adverse impacts during operation including use of water, production of wastewater and solid wastes, fire and safety hazards, and community and workers health and safety.

1. Air pollution

224. The primary emissions to air from the combustion of natural gas are sulfur dioxide (SO_2), nitrogen oxides (NO_X), particulate matter (PM), carbon monoxide (CO), and greenhouse gases such as carbon dioxide (CO_2).

225. Monitoring results of the gas-driven heat pump which will be installed by the component is presented in **Figure V-2** and **Table V-3**.

Figure V-2: Gas-driven heat pump monitoring results.

DZHJ/CX—D—28（05）

德州市环境保护监测中心站

烟尘（生产性排尘）、烟气监测结果报告表

共 1 页 第 1 页

编号：德环监字 2016 年 第 0427 号　　总共 1 页 第 1 页

委托单位	山东奇威特太阳能科技有限公司			监测目的	咨询服务
测试地点	燃气吸收式热泵机组			测试日期	2016.08.15
设备名称型号	VS/GH			运行负荷	100%
测试方法依据	烟气黑度	测烟望远镜法（《空气和废气监测分析方法》第四版增补版）	测试仪器型号	烟气黑度	DW10-II 测烟望远镜
	SO_2	定电位电解法（HJ/T57-2000）		SO_2	3012H 自动烟尘（气）测试仪
	NO_x	定电位电解法（HJ693-2014）		NO_x	
	颗粒物	《固定污染源排气中颗粒物的测定与气态污染物采样方法》（GB/T16157-1996）		颗粒物	

测试项目	测试结果			平均值	标准值	相应判定标准号
	1	2	3			
含氧量（%）	6.6	6.8	6.5	6.6	—	
SO_2 实测浓度（mg/m^3）	6	9	7	7	—	
SO_2 折算浓度（mg/m^3）	7	11	8	9	—	
SO_2 排放速率（kg/h）	0.0004	0.0006	0.0004	0.0005	—	
NO_x 实测浓度（mg/m^3）	15	28	23	22	—	
NO_x 折算浓度（mg/m^3）	18	35	28	27	—	
NO_x 排放速率（kg/h）	0.0009	0.0019	0.0015	0.0014	—	
颗粒物实测浓度（mg/m^3）	1.9	2.0	1.7	1.9	—	
颗粒物折算浓度（mg/m^3）	2.3	2.5	2.1	2.3	—	
颗粒物排放速率（kg/h）	0.0001	0.0001	0.0001	0.0001	—	
烟气黑度（林格曼级）	<1	<1	<1	<1	—	
烟气标干流量（Nm^3/h）	61	67	63	64	—	

说　明	不予判定				
备　注	该机组以天然气为燃料；排气筒高度为 2.5 米。				
报告表编制人		监测科室负责人		授　权签字人	

Table V-3: Gas driven heat pump monitoring results

Sample No.	Pollutants	Oxygen content	Results	Flow (m^3/h)	Emission rate (kg/h)
1	PM	6.6	2.3	61	0.0001
	SO_2		7	61	0.0004
	NOx		18	61	0.0009
2	PM	6.8	2.5	67	0.0001
	SO_2		11	67	0.0006
	NOx		35	67	0.0019
3	PM	6.5	2.1	63	0.0001
	SO_2		8	63	0.0004
	NOx		28	63	0.0015

226. Emission levels of the gas-driven heat pump in **Figure V-2** (SO_2: 11 mg/m^3; NOx: 35 mg/m^3; PM: 2.5 mg/m^3) can be compliance with the most stringent of PRC national and provincial standards (see **Table II-6**).

227. Gas fired boilers will be de designed to be compliance with the most stringent of PRC national and provincial standards (see **Table II-6**).

228. The main pollutants of concern in natural gas-fired boilers emissions are SO_2 and NOx. The report undertakes atmospheric dispersion modeling for SO_2 and NOx using SCREEN3, a US EPA approved screening model. The emission parameters utilized in the modeling are presented in **Table V-4.**

Table V-4: Exhaust Gas Emission Parameters of gas fired boilers

Community No.	Capacity	Stack height (m)	Inner diameter (m)	Natural gas consumption (m^3/h)	Exhaust air flow (m^3/h)	Emission rate (g/s) [15]	
						SO_2	NO_x
6	1x1.5MW and 1x3.5MW	18	0.6	600	7284	0.101	0.202
8	2x2.8MW	25	0.8	640	7769.6	0.108	0.216
20	2 x 2.8MW	25	0.8	640	7769.6	0.108	0.216
22	2x10.5 MW and 1x7 MW	50	1.8	3200	38848	0.540	1.079

[15]Burning 1m³ natural gas produces 12.14m³ waste gas. Based on Integrated Emission Standard of Air Pollutants for Shandong Province, emission concentrations of gas fired boiler are SO_2: 50 mg/m^3; NOx: 100 mg/m^3.

Community No.	Capacity	Stack height (m)	Inner diameter (m)	Natural gas consumption (m^3/h)	Exhaust air flow (m^3/h)	Emission rate (g/s) [15]	
						SO_2	NO_x
23	2x7MW	40	1.5	1600	19424	0.270	0.540

229. SCREEN3 can only calculate the 1-hour GLCs of SO_2 and NO_2. To make a better understanding of the impacts of the gas fired boilers, 24-hour and annual GLCs of SO_2 and NO_2 are calculated assuming that 24-hour GLCs is 1/3 of 1-hour GLCs and annual GLCs is 1/6 of 1-hour GLCs.[16]

230. The modeling results are presented from **Table V-5** to **Table V-16**and **Figure V-3** to **Figure V-10**.

231. The modeling results indicates that for No.6 community, the worst case 1-hour ground level concentration (GLC) of SO_2 from the two boilers is 1.87% of the PRC standard and the worst case 1-hour GLC of NO_2 is 9.37% of the PRC and WHO standard; the worst case 24-hour GLC of SO_2 is 2.08% of the PRC standard or 15.61% of WHO standard and the worst case 24-hour GLC of NO_2 is 7.80% of the PRC standard; the worst case annual GLC of SO_2 is 2.60% of the PRC standard and the worst case annual GLC of NO_2 is 7.80% of the PRC and WHO standard. The location with the maximum concentration is 85 m downwind of the pollution source.

232. The modeling results indicates that for No.8 and NO.20 community, the worst case 1-hour GLC of SO_2 from the two boilers is 0.97% of the PRC standard and the worst case 1-hour GLC of NO_2 is 4.83% of the PRC and WHO standard; the worst case 24-hour GLC of SO_2 is 1.07% of the PRC standard or 8.06% of WHO standard and the worst case 24-hour GLC of NO_2 is 4.03% of the PRC; the worst case annual GLC of SO_2 is 1.34% of the PRC standard and the worst case annual GLC of NO_2 is 4.03% of the PRC and WHO standard. The location with the maximum concentration is 119 m downwind of the pollution source.

233. The modeling results indicates that for NO.22 community, the worst case 1-hour GLC of SO_2 from the three boilers is 0.87% of the PRC standard and the worst case 1-hour GLC of NO_2 is 4.34% of the PRC and WHO standard; the worst case 24-hour GLC of SO_2 is 0.97% of the PRC standard or 7.24% of WHO standard and the worst case 24-hour GLC of NO_2 is 3.62% of the PRC; the worst case annual GLC of SO_2 is 1.21% of the PRC standard and the worst case annual GLC of NO_2 is 3.62% of the PRC and WHO standard. The location with the maximum concentration is 265 m downwind of the pollution source.

234. The modeling results indicates that for NO.23 community, the worst case 1-hour GLC of SO_2 from the two boilers is 0.70% of the PRC standard and the worst case 1-hour GLC of NO_2 is 3.52% of the PRC and WHO standard; the worst case 24-hour GLC of SO_2 is 0.78% of the PRC standard or 5.87% of WHO standard and the worst case 24-hour GLC of NO_2 is 2.93% of the PRC standard; the worst case annual GLC of SO_2 is 0.98% of the PRC standard and the worst case annual GLC of NO_2 is 2.93% of the PRC and WHO standard. The location with the maximum concentration is 212 m downwind of the pollution source.

235. All modeling results indicate compliance with relevant PRC standards and WHO standards. Once the component is in operation, the loan implementation environment consultant

[16] Technical Guidelines for Environmental Impact Assessment – Atmospheric Environment (HJ2.2-2018)

will support the IA in monitoring the offsets and include the information in the environmental monitoring reports submitted to ADB.

Table V-5: Predicted downwind direction pollutant 1-hour GLCs of No.6 community

No.	Distance from point pollution source (m)	SO_2			NO_2		
		Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)	Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)
1	10	0	0	NA	0.00E+00	0	0
2	85	9.37E-03	1.87%	NA	1.87E-02	9.37%	9.37%
3	100	8.93E-03	1.79%	NA	1.79E-02	8.93%	8.93%
4	200	6.27E-03	1.25%	NA	1.25E-02	6.27%	6.27%
5	300	3.54E-03	0.71%	NA	7.09E-03	3.54%	3.54%
6	400	3.29E-03	0.66%	NA	6.57E-03	3.29%	3.29%
7	500	2.83E-03	0.57%	NA	5.65E-03	2.82%	2.82%
8	600	2.38E-03	0.48%	NA	4.76E-03	2.38%	2.38%
9	700	2.01E-03	0.40%	NA	4.02E-03	2.01%	2.01%
10	800	1.72E-03	0.34%	NA	3.44E-03	1.72%	1.72%
11	900	1.49E-03	0.30%	NA	2.97E-03	1.49%	1.49%
12	1000	1.30E-03	0.26%	NA	2.60E-03	1.30%	1.30%
13	1100	1.15E-03	0.23%	NA	2.30E-03	1.15%	1.15%
14	1200	1.03E-03	0.21%	NA	2.06E-03	1.03%	1.03%
15	1300	9.26E-04	0.19%	NA	1.85E-03	0.93%	0.93%
16	1400	8.40E-04	0.17%	NA	1.68E-03	0.84%	0.84%
17	1500	7.68E-04	0.15%	NA	1.54E-03	0.77%	0.77%
18	1600	7.05E-04	0.14%	NA	1.41E-03	0.71%	0.71%
19	1700	6.51E-04	0.13%	NA	1.30E-03	0.65%	0.65%
20	1800	6.04E-04	0.12%	NA	1.21E-03	0.60%	0.60%
21	1900	5.63E-04	0.11%	NA	1.13E-03	0.56%	0.56%
22	2000	5.27E-04	0.11%	NA	1.05E-03	0.53%	0.53%
23	2100	4.94E-04	0.10%	NA	9.88E-04	0.49%	0.49%
24	2200	4.65E-04	0.09%	NA	9.30E-04	0.47%	0.47%
25	2300	4.39E-04	0.09%	NA	8.79E-04	0.44%	0.44%
26	2400	4.16E-04	0.08%	NA	8.32E-04	0.42%	0.42%
27	2500	3.95E-04	0.08%	NA	7.89E-04	0.39%	0.39%
Worst case GLC	**85**	**9.37E-03**	**1.87%**	**NA**	**1.87E-02**	**9.37%**	**9.37%**

Table V-6: Predicted downwind direction pollutant 24-hour GLCs of No.6 community

No.	Distance from point pollution source (m)	SO_2			NO_2		
		Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)	Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)
1	10	0	0	0	0	0	NA
2	85	3.12E-03	2.08%	15.61%	6.24E-03	7.80%	NA
3	100	2.98E-03	1.98%	14.89%	5.95E-03	7.44%	NA
4	200	2.09E-03	1.39%	10.44%	4.18E-03	5.22%	NA
5	300	1.18E-03	0.79%	5.91%	2.36E-03	2.95%	NA
6	400	1.10E-03	0.73%	5.48%	2.19E-03	2.74%	NA
7	500	9.42E-04	0.63%	4.71%	1.88E-03	2.35%	NA
8	600	7.93E-04	0.53%	3.97%	1.59E-03	1.98%	NA
9	700	6.70E-04	0.45%	3.35%	1.34E-03	1.68%	NA
10	800	5.73E-04	0.38%	2.87%	1.15E-03	1.43%	NA
11	900	4.96E-04	0.33%	2.48%	9.91E-04	1.24%	NA
12	1000	4.34E-04	0.29%	2.17%	8.68E-04	1.08%	NA
13	1100	3.84E-04	0.26%	1.92%	7.68E-04	0.96%	NA
14	1200	3.43E-04	0.23%	1.71%	6.86E-04	0.86%	NA
15	1300	3.09E-04	0.21%	1.54%	6.17E-04	0.77%	NA
16	1400	2.80E-04	0.19%	1.40%	5.60E-04	0.70%	NA
17	1500	2.56E-04	0.17%	1.28%	5.12E-04	0.64%	NA
18	1600	2.35E-04	0.16%	1.18%	4.70E-04	0.59%	NA
19	1700	2.17E-04	0.14%	1.09%	4.34E-04	0.54%	NA
20	1800	2.01E-04	0.13%	1.01%	4.03E-04	0.50%	NA
21	1900	1.88E-04	0.13%	0.94%	3.75E-04	0.47%	NA
22	2000	1.76E-04	0.12%	0.88%	3.51E-04	0.44%	NA
23	2100	1.65E-04	0.11%	0.82%	3.29E-04	0.41%	NA
24	2200	1.55E-04	0.10%	0.78%	3.10E-04	0.39%	NA
25	2300	1.46E-04	0.10%	0.73%	2.93E-04	0.37%	NA
26	2400	1.39E-04	0.09%	0.69%	2.77E-04	0.35%	NA
27	2500	1.32E-04	0.09%	0.66%	2.63E-04	0.33%	NA
Worst case GLC	**85**	**3.12E-03**	**2.08%**	**15.61%**	**6.24E-03**	**7.80%**	**NA**

Table V-7: Predicted downwind direction pollutant annual GLCs of No.6 community

No.	Distance from point pollution source (m)	SO_2			NO_2		
		Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)	Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)
1	10	0	0	0	0	0	0
2	85	1.56E-03	2.60%	NA	3.12E-03	7.80%	7.80%
3	100	1.49E-03	2.48%	NA	2.98E-03	7.44%	7.44%
4	200	1.04E-03	1.74%	NA	2.09E-03	5.22%	5.22%
5	300	5.91E-04	0.98%	NA	1.18E-03	2.95%	2.95%

6	400	5.48E-04	0.91%	NA	1.10E-03	2.74%	2.74%
7	500	4.71E-04	0.78%	NA	9.42E-04	2.35%	2.35%
8	600	3.97E-04	0.66%	NA	7.93E-04	1.98%	1.98%
9	700	3.35E-04	0.56%	NA	6.71E-04	1.68%	1.68%
10	800	2.87E-04	0.48%	NA	5.73E-04	1.43%	1.43%
11	900	2.48E-04	0.41%	NA	4.96E-04	1.24%	1.24%
12	1000	2.17E-04	0.36%	NA	4.34E-04	1.08%	1.08%
13	1100	1.92E-04	0.32%	NA	3.84E-04	0.96%	0.96%
14	1200	1.71E-04	0.29%	NA	3.43E-04	0.86%	0.86%
15	1300	1.54E-04	0.26%	NA	3.09E-04	0.77%	0.77%
16	1400	1.40E-04	0.23%	NA	2.80E-04	0.70%	0.70%
17	1500	1.28E-04	0.21%	NA	2.56E-04	0.64%	0.64%
18	1600	1.18E-04	0.20%	NA	2.35E-04	0.59%	0.59%
19	1700	1.09E-04	0.18%	NA	2.17E-04	0.54%	0.54%
20	1800	1.01E-04	0.17%	NA	2.01E-04	0.50%	0.50%
21	1900	9.38E-05	0.16%	NA	1.88E-04	0.47%	0.47%
22	2000	8.78E-05	0.15%	NA	1.76E-04	0.44%	0.44%
23	2100	8.24E-05	0.14%	NA	1.65E-04	0.41%	0.41%
24	2200	7.75E-05	0.13%	NA	1.55E-04	0.39%	0.39%
25	2300	7.32E-05	0.12%	NA	1.46E-04	0.37%	0.37%
26	2400	6.93E-05	0.12%	NA	1.39E-04	0.35%	0.35%
27	2500	6.58E-05	0.11%	NA	1.32E-04	0.33%	0.33%
Worst case GLC	**85**	**1.56E-03**	**2.60%**	**NA**	**3.12E-03**	**7.80%**	**7.80%**

Table V-8: Predicted downwind direction pollutant 1-hour GLCs of No.8 and No.20 community

No.	Distance from point pollution source (m)	SO_2			NO_2		
		Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)	Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)
1	10	0	0	0	0	0	0
2	100	4.54E-03	0.91%	NA	9.08E-03	4.54%	4.54%
3	119	4.83E-03	0.97%	NA	9.67E-03	4.83%	4.83%
4	200	4.32E-03	0.86%	NA	8.65E-03	4.32%	4.32%
5	300	2.96E-03	0.59%	NA	5.93E-03	2.96%	2.96%
6	400	1.98E-03	0.40%	NA	3.97E-03	1.98%	1.98%
7	500	1.92E-03	0.38%	NA	3.83E-03	1.92%	1.92%
8	600	1.76E-03	0.35%	NA	3.52E-03	1.76%	1.76%
9	700	1.57E-03	0.31%	NA	3.14E-03	1.57%	1.57%
10	800	1.39E-03	0.28%	NA	2.79E-03	1.39%	1.39%
11	900	1.24E-03	0.25%	NA	2.48E-03	1.24%	1.24%
12	1000	1.11E-03	0.22%	NA	2.22E-03	1.11%	1.11%
13	1100	9.95E-04	0.20%	NA	1.99E-03	1.00%	1.00%
14	1200	9.00E-04	0.18%	NA	1.80E-03	0.90%	0.90%
15	1300	8.19E-04	0.16%	NA	1.64E-03	0.82%	0.82%
16	1400	7.50E-04	0.15%	NA	1.50E-03	0.75%	0.75%
17	1500	6.90E-04	0.14%	NA	1.38E-03	0.69%	0.69%
18	1600	6.37E-04	0.13%	NA	1.28E-03	0.64%	0.64%

19	1700	5.92E-04	0.12%	NA	1.18E-03	0.59%	0.59%
20	1800	5.51E-04	0.11%	NA	1.10E-03	0.55%	0.55%
21	1900	5.16E-04	0.10%	NA	1.03E-03	0.52%	0.52%
22	2000	4.84E-04	0.10%	NA	9.68E-04	0.48%	0.48%
23	2100	4.56E-04	0.09%	NA	9.12E-04	0.46%	0.46%
24	2200	4.30E-04	0.09%	NA	8.61E-04	0.43%	0.43%
25	2300	4.07E-04	0.08%	NA	8.15E-04	0.41%	0.41%
26	2400	3.86E-04	0.08%	NA	7.73E-04	0.39%	0.39%
27	2500	3.67E-04	0.07%	NA	7.35E-04	0.37%	0.37%
Worst case GLC	**119**	**4.83E-03**	**0.97%**	NA	**9.67E-03**	**4.83%**	**4.83%**

Table V-9: Predicted downwind direction pollutant 24-hour GLCs of No.8 and No.20 community

No.	Distance from point pollution source (m)	SO_2			NO_2		
		Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)	Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)
1	10	0	0	0	0	0	0
2	100	1.51E-03	1.01%	7.57%	3.03E-03	3.78%	NA
3	119	1.61E-03	1.07%	8.06%	3.22E-03	4.03%	NA
4	200	1.44E-03	0.96%	7.21%	2.88E-03	3.60%	NA
5	300	9.87E-04	0.66%	4.94%	1.98E-03	2.47%	NA
6	400	6.61E-04	0.44%	3.31%	1.32E-03	1.65%	NA
7	500	6.39E-04	0.43%	3.19%	1.28E-03	1.60%	NA
8	600	5.86E-04	0.39%	2.93%	1.17E-03	1.46%	NA
9	700	5.23E-04	0.35%	2.62%	1.05E-03	1.31%	NA
10	800	4.65E-04	0.31%	2.32%	9.29E-04	1.16%	NA
11	900	4.13E-04	0.28%	2.07%	8.26E-04	1.03%	NA
12	1000	3.69E-04	0.25%	1.85%	7.38E-04	0.92%	NA
13	1100	3.32E-04	0.22%	1.66%	6.64E-04	0.83%	NA
14	1200	3.00E-04	0.20%	1.50%	6.00E-04	0.75%	NA
15	1300	2.73E-04	0.18%	1.37%	5.46E-04	0.68%	NA
16	1400	2.50E-04	0.17%	1.25%	5.00E-04	0.62%	NA
17	1500	2.30E-04	0.15%	1.15%	4.60E-04	0.57%	NA
18	1600	2.12E-04	0.14%	1.06%	4.25E-04	0.53%	NA
19	1700	1.97E-04	0.13%	0.99%	3.94E-04	0.49%	NA
20	1800	1.84E-04	0.12%	0.92%	3.68E-04	0.46%	NA
21	1900	1.72E-04	0.11%	0.86%	3.44E-04	0.43%	NA
22	2000	1.61E-04	0.11%	0.81%	3.23E-04	0.40%	NA
23	2100	1.52E-04	0.10%	0.76%	3.04E-04	0.38%	NA
24	2200	1.43E-04	0.10%	0.72%	2.87E-04	0.36%	NA
25	2300	1.36E-04	0.09%	0.68%	2.72E-04	0.34%	NA
26	2400	1.29E-04	0.09%	0.64%	2.58E-04	0.32%	NA
27	2500	1.22E-04	0.08%	0.61%	2.45E-04	0.31%	NA
Worst case GLC	**119**	**1.61E-03**	**1.07%**	**8.06%**	**3.22E-03**	**4.03%**	**NA**

Table V-10: Predicted downwind direction pollutant annual GLCs of No.8 and No.20 community

No.	Distance from point pollution source (m)	SO_2			NO_2		
		Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)	Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)
1	10	0	0	0	0	0	0
2	100	7.57E-04	1.26%	NA	1.51E-03	3.78%	3.78%
3	119	8.06E-04	1.34%	NA	1.61E-03	4.03%	4.03%
4	200	7.21E-04	1.20%	NA	1.44E-03	3.60%	3.60%
5	300	4.94E-04	0.82%	NA	9.88E-04	2.47%	2.47%
6	400	3.31E-04	0.55%	NA	6.61E-04	1.65%	1.65%
7	500	3.19E-04	0.53%	NA	6.39E-04	1.60%	1.60%
8	600	2.93E-04	0.49%	NA	5.86E-04	1.46%	1.46%
9	700	2.62E-04	0.44%	NA	5.23E-04	1.31%	1.31%
10	800	2.32E-04	0.39%	NA	4.65E-04	1.16%	1.16%
11	900	2.07E-04	0.34%	NA	4.13E-04	1.03%	1.03%
12	1000	1.85E-04	0.31%	NA	3.69E-04	0.92%	0.92%
13	1100	1.66E-04	0.28%	NA	3.32E-04	0.83%	0.83%
14	1200	1.50E-04	0.25%	NA	3.00E-04	0.75%	0.75%
15	1300	1.37E-04	0.23%	NA	2.73E-04	0.68%	0.68%
16	1400	1.25E-04	0.21%	NA	2.50E-04	0.62%	0.62%
17	1500	1.15E-04	0.19%	NA	2.30E-04	0.57%	0.57%
18	1600	1.06E-04	0.18%	NA	2.13E-04	0.53%	0.53%
19	1700	9.86E-05	0.16%	NA	1.97E-04	0.49%	0.49%
20	1800	9.19E-05	0.15%	NA	1.84E-04	0.46%	0.46%
21	1900	8.60E-05	0.14%	NA	1.72E-04	0.43%	0.43%
22	2000	8.07E-05	0.13%	NA	1.61E-04	0.40%	0.40%
23	2100	7.60E-05	0.13%	NA	1.52E-04	0.38%	0.38%
24	2200	7.17E-05	0.12%	NA	1.43E-04	0.36%	0.36%
25	2300	6.79E-05	0.11%	NA	1.36E-04	0.34%	0.34%
26	2400	6.44E-05	0.11%	NA	1.29E-04	0.32%	0.32%
27	2500	6.12E-05	0.10%	NA	1.22E-04	0.31%	0.31%
Worst case GLC	**119**	**8.06E-04**	**1.34%**	**NA**	**1.61E-03**	**4.03%**	**4.03%**

Table V-11: Predicted downwind direction pollutant 1-hour GLCs of No.22 community

No.	Distance from point pollution source (m)	SO_2			NO_2		
		Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)	Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)
1	10	0	0	0	0	0	0
2	100	1.41E-03	0.28%	NA	2.83E-03	1.41%	1.41%
3	200	3.94E-03	0.79%	NA	7.87E-03	3.94%	3.94%
4	265	4.35E-03	0.87%	NA	8.68E-03	4.34%	4.34%
5	300	4.23E-03	0.85%	NA	8.46E-03	4.23%	4.23%

6	400	3.97E-03	0.79%	NA	7.94E-03	3.97%	3.97%
7	500	3.60E-03	0.72%	NA	7.20E-03	3.60%	3.60%
8	600	3.07E-03	0.61%	NA	6.14E-03	3.07%	3.07%
9	700	2.59E-03	0.52%	NA	5.18E-03	2.59%	2.59%
10	800	2.19E-03	0.44%	NA	4.38E-03	2.19%	2.19%
11	900	2.13E-03	0.43%	NA	4.26E-03	2.13%	2.13%
12	1000	2.14E-03	0.43%	NA	4.27E-03	2.14%	2.14%
13	1100	2.10E-03	0.42%	NA	4.20E-03	2.10%	2.10%
14	1200	2.04E-03	0.41%	NA	4.08E-03	2.04%	2.04%
15	1300	1.97E-03	0.39%	NA	3.94E-03	1.97%	1.97%
16	1400	1.89E-03	0.38%	NA	3.78E-03	1.89%	1.89%
17	1500	1.81E-03	0.36%	NA	3.62E-03	1.81%	1.81%
18	1600	1.74E-03	0.35%	NA	3.47E-03	1.73%	1.73%
19	1700	1.66E-03	0.33%	NA	3.32E-03	1.66%	1.66%
20	1800	1.59E-03	0.32%	NA	3.17E-03	1.59%	1.59%
21	1900	1.52E-03	0.30%	NA	3.03E-03	1.52%	1.52%
22	2000	1.45E-03	0.29%	NA	2.90E-03	1.45%	1.45%
23	2100	1.39E-03	0.28%	NA	2.78E-03	1.39%	1.39%
24	2200	1.34E-03	0.27%	NA	2.67E-03	1.33%	1.33%
25	2300	1.28E-03	0.26%	NA	2.56E-03	1.28%	1.28%
26	2400	1.23E-03	0.25%	NA	2.46E-03	1.23%	1.23%
27	2500	1.19E-03	0.24%	NA	2.37E-03	1.18%	1.18%
Worst case GLC	**265**	**4.35E-03**	**0.87%**	**NA**	**8.68E-03**	**4.34%**	**4.34%**

Table V-12: Predicted downwind direction pollutant 24-hour GLCs of No.22 community

No.	Distance from point pollution source (m)	SO_2			NO_2		
		Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)	Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)
1	10	0	0	0	0	0	0
2	100	4.71E-04	0.31%	2.36%	9.42E-04	1.18%	NA
3	200	1.31E-03	0.88%	6.57%	2.62E-03	3.28%	NA
4	265	1.45E-03	0.97%	7.24%	2.89E-03	3.62%	NA
5	300	1.41E-03	0.94%	7.06%	2.82E-03	3.52%	NA
6	400	1.32E-03	0.88%	6.62%	2.65E-03	3.31%	NA
7	500	1.20E-03	0.80%	6.00%	2.40E-03	3.00%	NA
8	600	1.02E-03	0.68%	5.12%	2.05E-03	2.56%	NA
9	700	8.63E-04	0.58%	4.32%	1.73E-03	2.16%	NA
10	800	7.30E-04	0.49%	3.65%	1.46E-03	1.82%	NA
11	900	7.11E-04	0.47%	3.55%	1.42E-03	1.78%	NA
12	1000	7.13E-04	0.48%	3.57%	1.42E-03	1.78%	NA
13	1100	7.01E-04	0.47%	3.51%	1.40E-03	1.75%	NA
14	1200	6.81E-04	0.45%	3.41%	1.36E-03	1.70%	NA
15	1300	6.57E-04	0.44%	3.29%	1.31E-03	1.64%	NA
16	1400	6.31E-04	0.42%	3.16%	1.26E-03	1.58%	NA
17	1500	6.05E-04	0.40%	3.02%	1.21E-03	1.51%	NA
18	1600	5.78E-04	0.39%	2.89%	1.16E-03	1.44%	NA

19	1700	5.53E-04	0.37%	2.77%	1.11E-03	1.38%	NA
20	1800	5.29E-04	0.35%	2.65%	1.06E-03	1.32%	NA
21	1900	5.06E-04	0.34%	2.53%	1.01E-03	1.26%	NA
22	2000	4.84E-04	0.32%	2.42%	9.68E-04	1.21%	NA
23	2100	4.64E-04	0.31%	2.32%	9.27E-04	1.16%	NA
24	2200	4.45E-04	0.30%	2.23%	8.89E-04	1.11%	NA
25	2300	4.27E-04	0.28%	2.14%	8.54E-04	1.07%	NA
26	2400	4.11E-04	0.27%	2.05%	8.21E-04	1.03%	NA
27	2500	3.95E-04	0.26%	1.98%	7.89E-04	0.99%	NA
Worst case GLC	**265**	**1.45E-03**	**0.97%**	**7.24%**	**2.89E-03**	**3.62%**	**NA**

Table V-13: Predicted downwind direction pollutant annual GLCs of No.22 community

No.	Distance from point pollution source (m)	SO_2			NO_2		
		Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)	Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)
1	10	0	0	0	0	0	0
2	100	2.36E-04	0.39%	NA	4.71E-04	1.18%	1.18%
3	200	6.57E-04	1.09%	NA	1.31E-03	3.28%	3.28%
4	265	7.24E-04	1.21%	NA	1.45E-03	3.62%	3.62%
5	300	7.06E-04	1.18%	NA	1.41E-03	3.52%	3.52%
6	400	6.62E-04	1.10%	NA	1.32E-03	3.31%	3.31%
7	500	6.00E-04	1.00%	NA	1.20E-03	3.00%	3.00%
8	600	5.12E-04	0.85%	NA	1.02E-03	2.56%	2.56%
9	700	4.32E-04	0.72%	NA	8.63E-04	2.16%	2.16%
10	800	3.65E-04	0.61%	NA	7.30E-04	1.82%	1.82%
11	900	3.55E-04	0.59%	NA	7.10E-04	1.78%	1.78%
12	1000	3.57E-04	0.59%	NA	7.12E-04	1.78%	1.78%
13	1100	3.51E-04	0.58%	NA	7.01E-04	1.75%	1.75%
14	1200	3.41E-04	0.57%	NA	6.81E-04	1.70%	1.70%
15	1300	3.29E-04	0.55%	NA	6.57E-04	1.64%	1.64%
16	1400	3.16E-04	0.53%	NA	6.31E-04	1.58%	1.58%
17	1500	3.02E-04	0.50%	NA	6.04E-04	1.51%	1.51%
18	1600	2.89E-04	0.48%	NA	5.78E-04	1.44%	1.44%
19	1700	2.77E-04	0.46%	NA	5.53E-04	1.38%	1.38%
20	1800	2.65E-04	0.44%	NA	5.28E-04	1.32%	1.32%
21	1900	2.53E-04	0.42%	NA	5.06E-04	1.26%	1.26%
22	2000	2.42E-04	0.40%	NA	4.84E-04	1.21%	1.21%
23	2100	2.32E-04	0.39%	NA	4.64E-04	1.16%	1.16%
24	2200	2.23E-04	0.37%	NA	4.45E-04	1.11%	1.11%
25	2300	2.14E-04	0.36%	NA	4.27E-04	1.07%	1.07%
26	2400	2.05E-04	0.34%	NA	4.10E-04	1.03%	1.03%
27	2500	1.98E-04	0.33%	NA	3.95E-04	0.99%	0.99%
Worst case GLC	**265**	**7.24E-04**	**1.21%**	**NA**	**1.45E-03**	**3.62%**	**3.62%**

Table V-14: Predicted downwind direction pollutant 1-hour GLCs of No.23 community

No.	Distance from point pollution source (m)	SO_2			NO_2		
		Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)	Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)
1	10	0	0	0	0	0	0
2	100	1.94E-03	0.39%	NA	3.88E-03	1.94%	1.94%
3	200	3.50E-03	0.70%	NA	7.00E-03	3.50%	3.50%
4	212	3.52E-03	0.70%	NA	7.04E-03	3.52%	3.52%
5	300	3.25E-03	0.65%	NA	6.51E-03	3.25%	3.25%
6	400	2.92E-03	0.58%	NA	5.84E-03	2.92%	2.92%
7	500	2.37E-03	0.47%	NA	4.74E-03	2.37%	2.37%
8	600	1.90E-03	0.38%	NA	3.80E-03	1.90%	1.90%
9	700	1.68E-03	0.34%	NA	3.36E-03	1.68%	1.68%
10	800	1.68E-03	0.34%	NA	3.37E-03	1.68%	1.68%
11	900	1.64E-03	0.33%	NA	3.27E-03	1.64%	1.64%
12	1000	1.56E-03	0.31%	NA	3.13E-03	1.56%	1.56%
13	1100	1.48E-03	0.30%	NA	2.96E-03	1.48%	1.48%
14	1200	1.40E-03	0.28%	NA	2.79E-03	1.40%	1.40%
15	1300	1.31E-03	0.26%	NA	2.63E-03	1.31%	1.31%
16	1400	1.24E-03	0.25%	NA	2.47E-03	1.24%	1.24%
17	1500	1.17E-03	0.23%	NA	2.33E-03	1.16%	1.16%
18	1600	1.10E-03	0.22%	NA	2.20E-03	1.10%	1.10%
19	1700	1.04E-03	0.21%	NA	2.07E-03	1.04%	1.04%
20	1800	9.81E-04	0.20%	NA	1.96E-03	0.98%	0.98%
21	1900	9.30E-04	0.19%	NA	1.86E-03	0.93%	0.93%
22	2000	8.83E-04	0.18%	NA	1.77E-03	0.88%	0.88%
23	2100	8.39E-04	0.17%	NA	1.68E-03	0.84%	0.84%
24	2200	8.00E-04	0.16%	NA	1.60E-03	0.80%	0.80%
25	2300	7.63E-04	0.15%	NA	1.53E-03	0.76%	0.76%
26	2400	7.30E-04	0.15%	NA	1.46E-03	0.73%	0.73%
27	2500	6.98E-04	0.14%	NA	1.40E-03	0.70%	0.70%
Worst case GLC	**212**	**3.52E-03**	**0.70%**	**NA**	**7.04E-03**	**3.52%**	**3.52%**

Table V-15: Predicted downwind direction pollutant 24-hour GLCs of No.23 community

No.	Distance from point pollution source (m)	SO_2			NO_2		
		Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)	Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)
1	10	0	0	0	0	0	0
2	100	6.47E-04	0.43%	3.24%	1.29E-03	1.62%	NA
3	200	1.17E-03	0.78%	5.83%	2.33E-03	2.91%	NA
4	212	1.17E-03	0.78%	5.87%	2.35E-03	2.93%	NA
5	300	1.08E-03	0.72%	5.42%	2.17E-03	2.71%	NA

6	400	9.73E-04	0.65%	4.87%	1.95E-03	2.43%	NA
7	500	7.90E-04	0.53%	3.95%	1.58E-03	1.97%	NA
8	600	6.34E-04	0.42%	3.17%	1.27E-03	1.58%	NA
9	700	5.60E-04	0.37%	2.80%	1.12E-03	1.40%	NA
10	800	5.61E-04	0.37%	2.81%	1.12E-03	1.40%	NA
11	900	5.45E-04	0.36%	2.73%	1.09E-03	1.36%	NA
12	1000	5.21E-04	0.35%	2.61%	1.04E-03	1.30%	NA
13	1100	4.94E-04	0.33%	2.47%	9.87E-04	1.23%	NA
14	1200	4.65E-04	0.31%	2.33%	9.31E-04	1.16%	NA
15	1300	4.38E-04	0.29%	2.19%	8.76E-04	1.10%	NA
16	1400	4.12E-04	0.27%	2.06%	8.24E-04	1.03%	NA
17	1500	3.88E-04	0.26%	1.94%	7.76E-04	0.97%	NA
18	1600	3.66E-04	0.24%	1.83%	7.32E-04	0.92%	NA
19	1700	3.46E-04	0.23%	1.73%	6.91E-04	0.86%	NA
20	1800	3.27E-04	0.22%	1.63%	6.54E-04	0.82%	NA
21	1900	3.10E-04	0.21%	1.55%	6.20E-04	0.77%	NA
22	2000	2.94E-04	0.20%	1.47%	5.88E-04	0.74%	NA
23	2100	2.80E-04	0.19%	1.40%	5.60E-04	0.70%	NA
24	2200	2.67E-04	0.18%	1.33%	5.33E-04	0.67%	NA
25	2300	2.54E-04	0.17%	1.27%	5.09E-04	0.64%	NA
26	2400	2.43E-04	0.16%	1.22%	4.86E-04	0.61%	NA
27	2500	2.33E-04	0.16%	1.16%	4.66E-04	0.58%	NA
Worst case GLC	**212**	**1.17E-03**	**0.78%**	**5.87%**	**2.35E-03**	**2.93%**	**NA**

Table V-16: Predicted downwind direction pollutant annual GLCs of No.23 community

No.	Distance from point pollution source (m)	SO_2			NO_2		
		Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)	Predicted downwind GLC (ug/m^3)	Ratio of GLC to PRC Standard (%)	Ratio of GLC to WHO Standard (%)
1	10	0	0	0	0	0	0
2	100	3.24E-04	0.54%	NA	6.47E-04	1.62%	1.62%
3	200	5.83E-04	0.97%	NA	1.17E-03	2.91%	2.91%
4	212	5.87E-04	0.98%	NA	1.17E-03	2.93%	2.93%
5	300	5.42E-04	0.90%	NA	1.08E-03	2.71%	2.71%
6	400	4.87E-04	0.81%	NA	9.73E-04	2.43%	2.43%
7	500	3.95E-04	0.66%	NA	7.90E-04	1.97%	1.97%
8	600	3.17E-04	0.53%	NA	6.34E-04	1.58%	1.58%
9	700	2.80E-04	0.47%	NA	5.60E-04	1.40%	1.40%
10	800	2.81E-04	0.47%	NA	5.61E-04	1.40%	1.40%
11	900	2.73E-04	0.45%	NA	5.45E-04	1.36%	1.36%
12	1000	2.61E-04	0.43%	NA	5.21E-04	1.30%	1.30%
13	1100	2.47E-04	0.41%	NA	4.94E-04	1.23%	1.23%
14	1200	2.33E-04	0.39%	NA	4.65E-04	1.16%	1.16%
15	1300	2.19E-04	0.37%	NA	4.38E-04	1.10%	1.10%
16	1400	2.06E-04	0.34%	NA	4.12E-04	1.03%	1.03%
17	1500	1.94E-04	0.32%	NA	3.88E-04	0.97%	0.97%
18	1600	1.83E-04	0.31%	NA	3.66E-04	0.92%	0.92%

19	1700	1.73E-04	0.29%	NA	3.46E-04	0.86%	0.86%
20	1800	1.63E-04	0.27%	NA	3.27E-04	0.82%	0.82%
21	1900	1.55E-04	0.26%	NA	3.10E-04	0.77%	0.77%
22	2000	1.47E-04	0.25%	NA	2.94E-04	0.74%	0.74%
23	2100	1.40E-04	0.23%	NA	2.80E-04	0.70%	0.70%
24	2200	1.33E-04	0.22%	NA	2.67E-04	0.67%	0.67%
25	2300	1.27E-04	0.21%	NA	2.54E-04	0.64%	0.64%
26	2400	1.22E-04	0.20%	NA	2.43E-04	0.61%	0.61%
27	2500	1.16E-04	0.19%	NA	2.33E-04	0.58%	0.58%
Worst case GLC	**212**	**5.87E-04**	**0.98%**	**NA**	**1.17E-03**	**2.93%**	**2.93%**

Figure V-3: Predicted Downwind Direction 1-h SO_2 GLC of No.6 community.

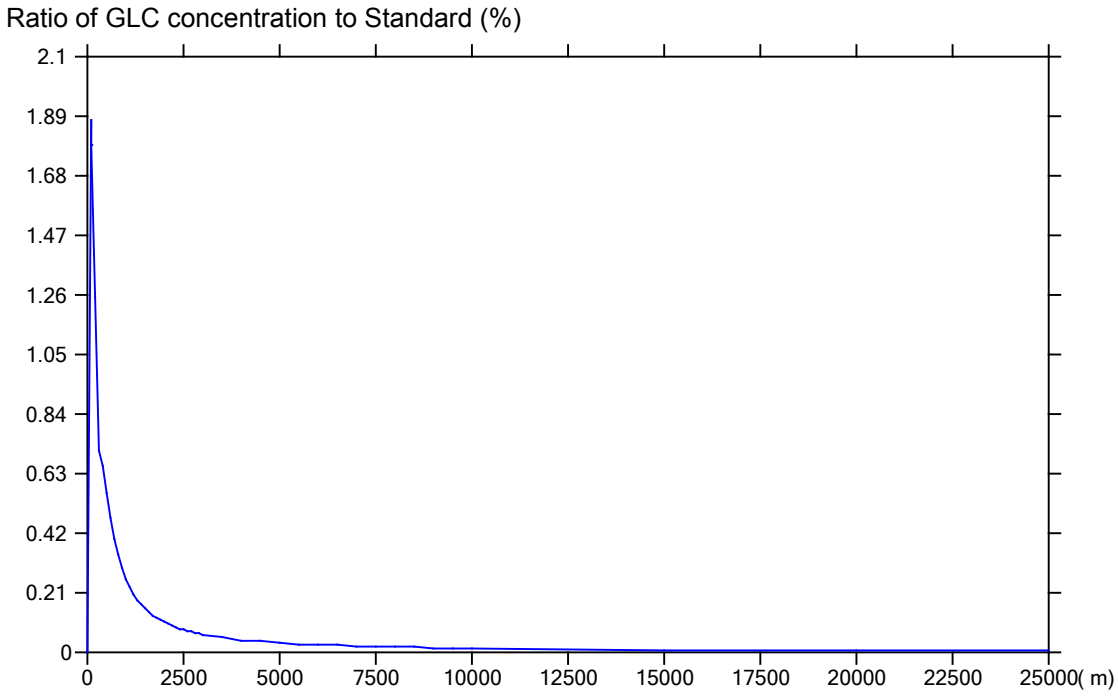


Figure V-4: Predicted Downwind Direction 1-h NO_2 GLC of No.6 community.

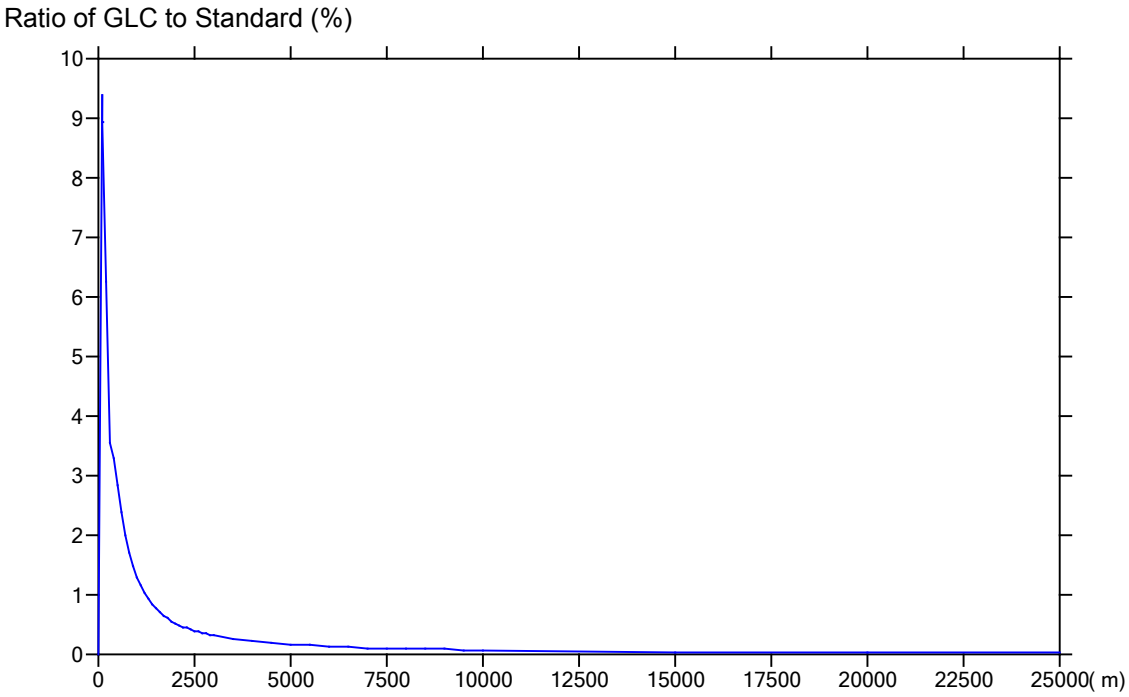


Figure V-5: Predicted Downwind Direction 1-h SO_2 GLC of No.8 and No.20 community.

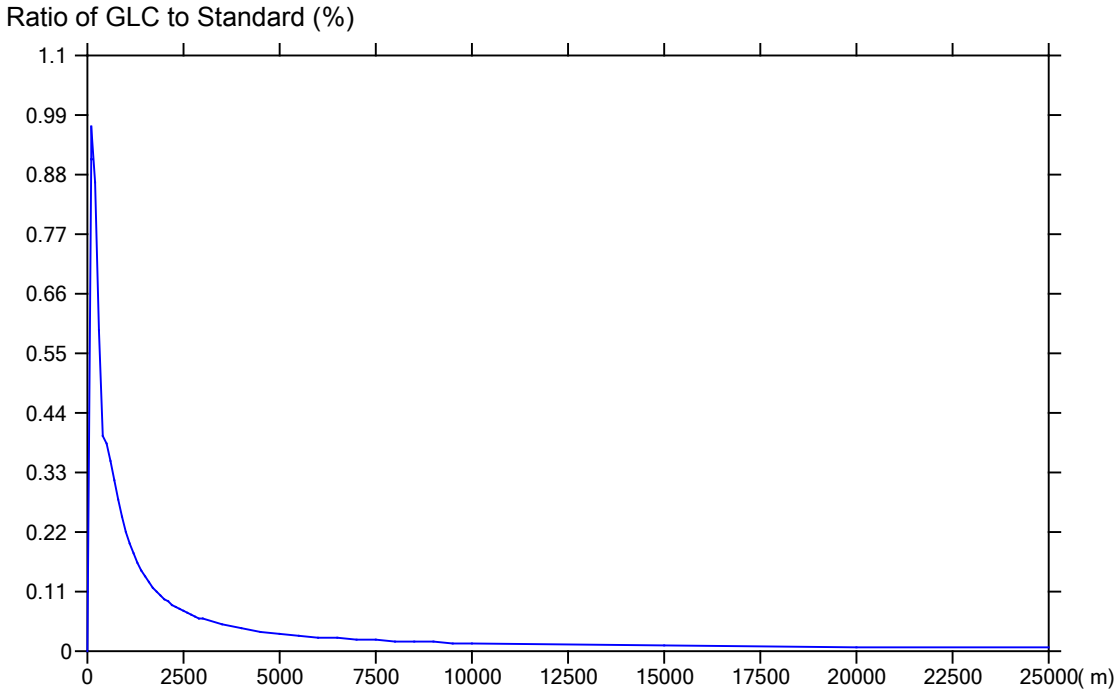


Figure V-6: Predicted Downwind Direction 1-h NO_2 GLC of No.8 and No.20 community.

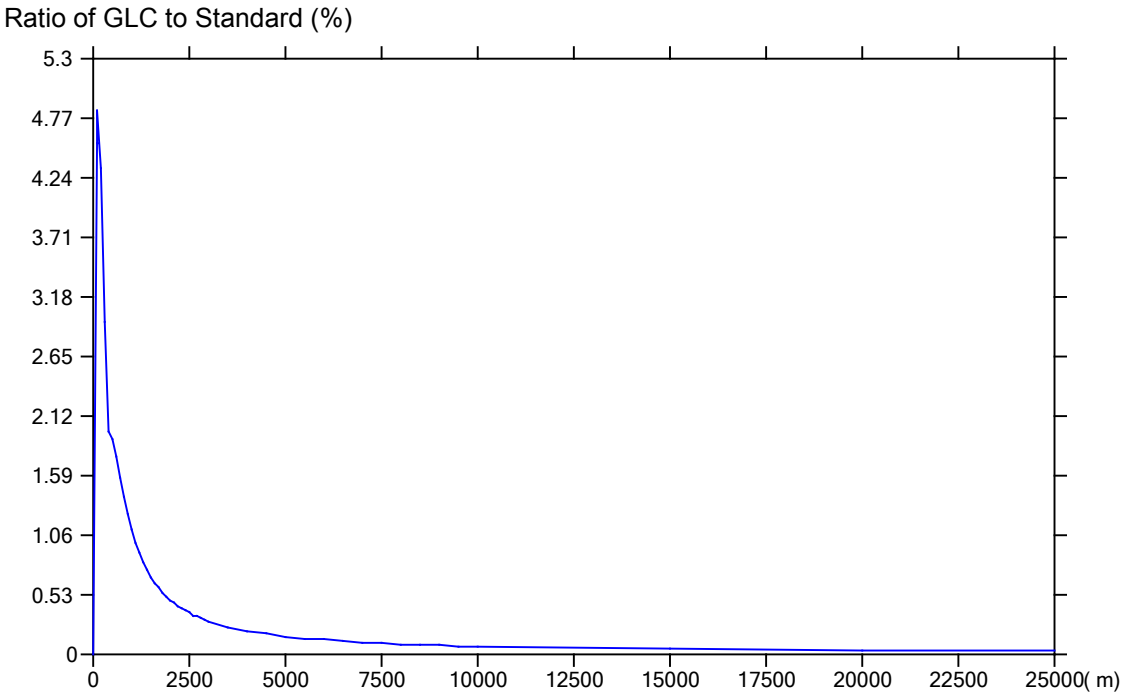


Figure V-7: Predicted Downwind Direction 1-h SO_2 GLC of No.22 community.

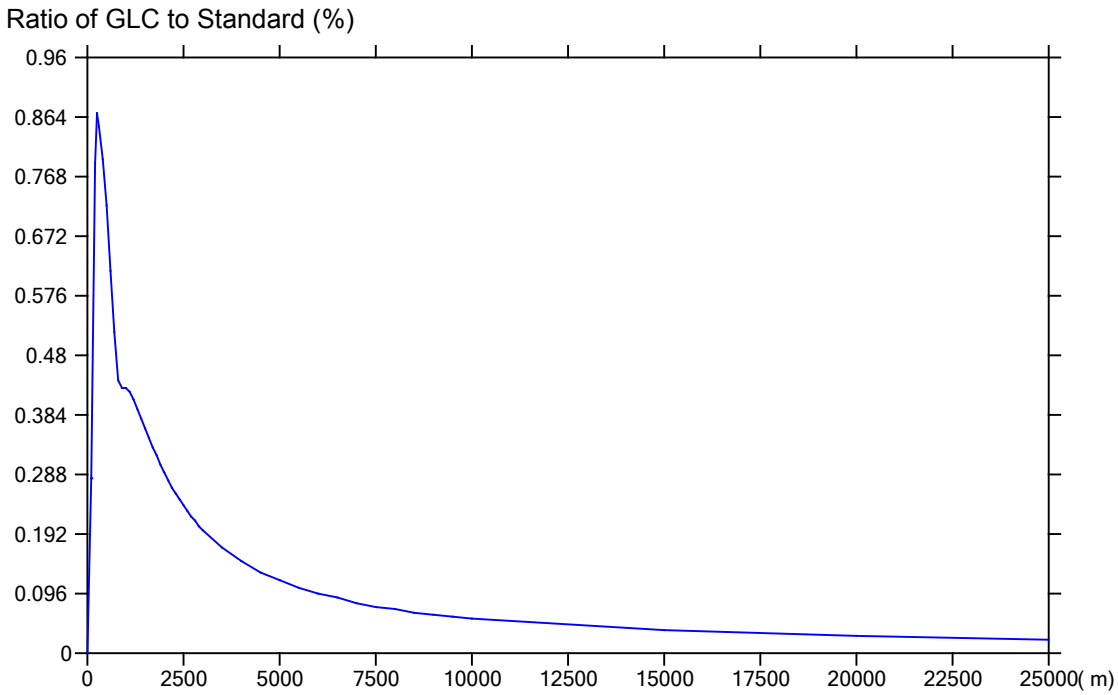


Figure V-8: Predicted Downwind Direction 1-h NO_2 GLC of No.22 community.

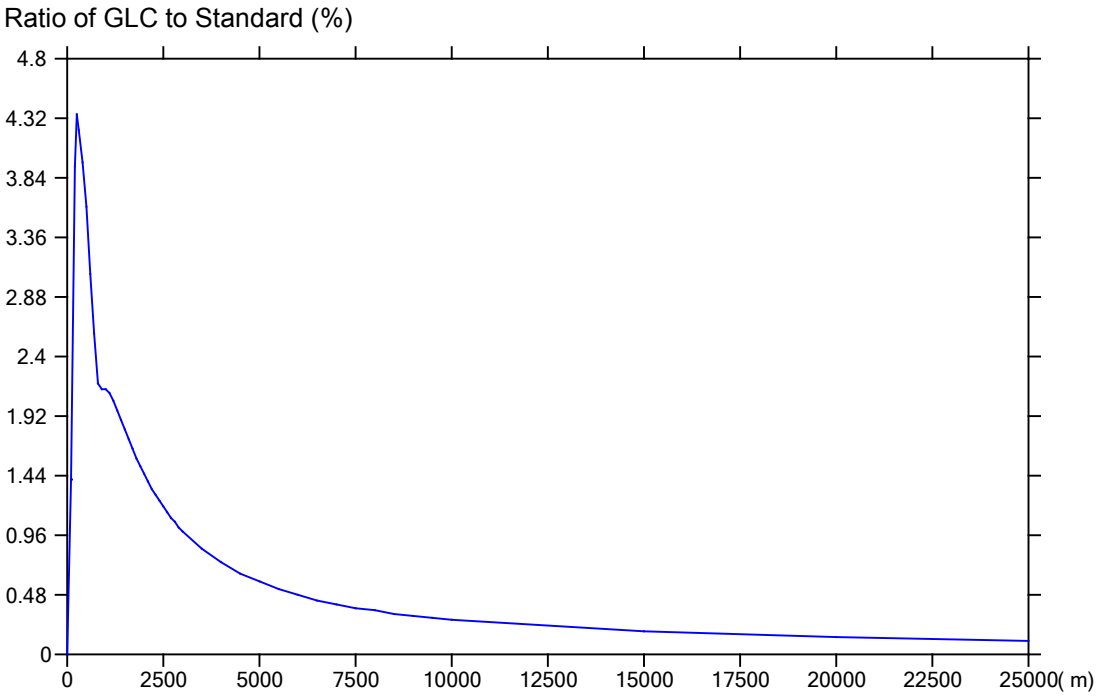


Figure V-9: Predicted Downwind Direction 1-h SO_2 GLC of No.23 community.

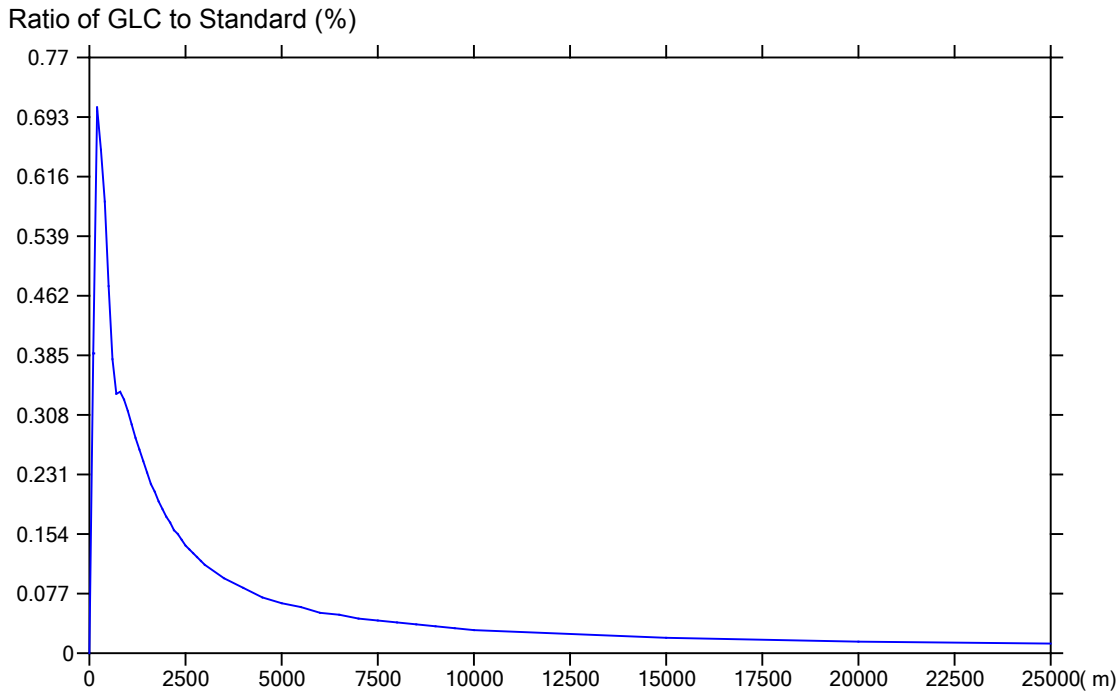
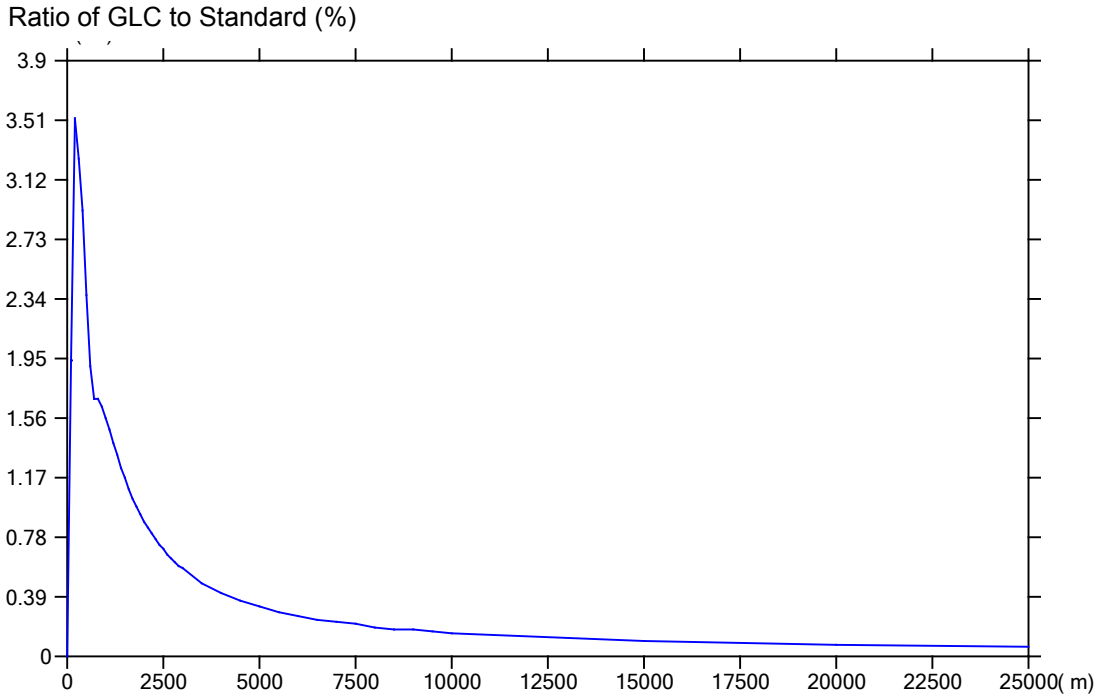


Figure V-10: Predicted Downwind Direction 1-h NO_2 GLC of No.23 community.



2. Water supply and wastewater pollution

236. The component will have 70 staff. Daily water consumption is 3.5 tons and annual is 525 tons (150 working days) for the component. The total water supply plant in Jinan urban is 910,000 tons per day. The total municipal water consumption is very limited compared to Jinan's water supply capacity. This is not expected to result in any significant negative impact on Jinan's water supply. Water supply agreement will be signed before the operation of the component.

237. The component will use municipal water as domestic water and production water. Domestic wastewater will be produced from and toilet facilities. Production wastewater will include wastewater from boilers, soften water treatment workshop and heating system.

238. Once operational, annual wastewater discharged by the component will be 37,560 m^3 and pollutants concentration in the wastewater is presented in **Table V-17** which can meet Class B maximum acceptable concentrations (MACs) in *Wastewater Quality Standards for Discharge to Municipal Sewers* (GB/T 31962-2015). The wastewater will be treated in nearby WWTP and discharged to Xiaoqing River. Estimated COD and ammonia nitrogen discharged by the component are 71.24 and 7.59 tons respectively.

Table V-17: Wastewater quantity and quality

Item	Annual flow (m^3)	Unit	COD	Ammonia nitrogen
Wastewater generated in heating season	37,560	mg/L	114.8	29.5
		tons	4.3	1.1

239. To address production and domestic wastewater, good practice water management measures per the general EHS Guidelines and the following measures will be implemented:

(i) Wastewater from soften water treatment process and regeneration processes will be discharged to the municipal sewerage system.

(ii) Boiler blow down, heating system blow down will be discharged to the municipal sewerage system.

(i) No metal (chromium or zinc) permitted to use as scaling and corrosion additive.

(ii) Because wastewater generated by equipment and pump contains oil, the wastewater will be treated in oil separator and will be discharged to the municipal sewerage system.

(iii) Domestic wastewater will be produced from worker sanitation facilities. Domestic wastewater will be treated in digestion tank and will be discharged to the municipal sewerage system.

3. Solid Waste

240. The component will generate a domestic waste and production waste. Production waste will be generated from equipment maintenance and waste thermal insulation materials. If not properly managed this waste can cause visual and environmental impacts. To mitigate this risk, the following measures and good practice waste management measures per the EHS General Guidelines, EHS Guidelines for Environmental Waste Management, EHS Guidelines for Thermal Power Plants and national regulations will be implemented:

(i) Domestic waste bins will be provided and domestic waste will be routinely collected by the local sanitation department for recycling, if possible, or final disposal at an approved waste disposal site.

(ii) No permanent on-site solid waste disposal will be permitted at the component site.

(iii) No burning of wastes will be permitted at the component site.

(iv) Oily waste from equipment maintenance will be collected, transported and treated by a certified 3rd party hazardous waste treatment company.

4. Chemicals and Hazardous Materials

241. Toxic, hazardous, and harmful materials present in the operation of the component include solvents, scale and corrosion inhibitors and chemicals used for water analysis and purification (which are Ethylene Diamine Tetraacetic Acid, Silver nitrate standard solution, Dilute sulphuric acid standard solution, Potassium chromate indicator, Erio-chrome black T indicator, Methyl orange indicator, Ammonia - ammonium chloride buffer solution, Sodium hydroxide solution and

Phenolphthalein indicator), waste lubrication oil and waste oil-contained fabric, and waste ion exchange resin. Toxic chemicals and hazardous wastes can have negative impacts on human health and the environment if not appropriately managed. Special care and good practice hazardous materials measures per the EHS General Guidelines and will be taken to mitigate these risks, including:

(i) A registry of all activities that involve the handling of potentially hazardous substances will be developed, including protocols for the storage, handling and spill response. This will include all fuels, oils, grease, lubricants, and other chemicals.

(ii) All chemicals, toxic, hazardous, and harmful materials will be transported in spill proof tanks with filling hoses and nozzles in working order.

(iii) All chemicals, toxic, hazardous, and harmful materials will be stored in secure areas with impermeable surfaces and protective dikes such that spillage or leakage will be contained from affecting soil, surface water or groundwater systems. The area should be 110% volume of storage capacity. Their usage will be strictly monitored and recorded.

(iv) Material safety data sheets (MSDSs) will be posted for all hazardous materials.

(v) Oil absorbents will be readily accessible in marked containers.

(vi) Good housekeeping procedures will be established to avoid the risk of spills.

(vii) Spills will be dealt with immediately, and personnel will be trained and tasked with this responsibility.

(viii) Workers will be properly trained before handling hazardous wastes and have the requisite PPE.

(ix) Hazardous waste will be temporarily stored in closed containers away from direct sunlight, wind, water and rain in secure designated areas with impermeable surfaces and protective dikes such that spillage or leakage will be contained.

(x) Hazardous wastes including oily waste, waste chemicals and waste ion exchange resin will be collected and disposed by licensed contractors.

(xi) Engineering and administrative control measures will be implemented to avoid or minimize the release of hazardous substances into the work environment keeping the level of exposure below internationally established or recognized limits.

(xii) Keep the number of employees exposed, or likely to become exposed, to a minimum to hazardous substances.

(xiii) Communicating chemical hazards to workers through labeling and marking according to national and internationally recognized requirements and standards, including the International Chemical Safety Cards (ICSC), Materials Safety Data Sheets (MSDS), or equivalent. Any means of written communication should be in an easily understood language and be readily available to exposed workers and first-aid personnel.

(xiv) Training workers in the use of the available information (such as MSDSs), safe work practices, and appropriate use of PPE.

5. Noise

242. Noise sources during operation will mainly be from noise from pumps, boiler, etc. At the sensitive receptors, noise emission shall meet the requirements of 45 dB during night time and 55 dB during daytime. To mitigate noise impacts the component will:

(i) Low-noise equipment will be used as far as possible, and noise reduction measures such as noise elimination, shock absorption, insulated enclosures and sound dampening materials on exterior walls will be implemented.

(ii) All equipment will be properly maintained in order to minimize noise.

(iii) Appropriate noise PPE will be provided to the workers who are likely to be exposed to high noise level environments to meet the requirements in occupational exposure limits for hazardous agents in work place Part 2: physical agents (GBZ 2.2-2007) and EHG Guidelines on Occupational H&S.

(iv) Layout for component site will be reasonable planned to reduce noise.

6. Community and Occupational Health and Safety

243. Plant operation poses potential risks to workers and community, including potential fire hazard and noise pollution. Natural gas also presents fire, burn and explosive hazards.

244. To minimize risks associated with leaks of natural gas, the following measures and good practice measures per the EHS Guidelines on occupational H&S will be taken:

(i) All natural gas works will be in compliance with relevant PRC building code requirements, including the *Code for Design of City Gas Engineering* (GB 50028-2006) and *Regulation on Electric Apparatus Design for Explosion and Fire Risk Environment* (GB50058-92).

(ii) Independent gas regulation stations will be constructed at least 12 meters away from other buildings and 30 m from the site boundary, to minimize the risk of explosion damaging other project facilities or the public.[17]

(iii) The gas regulation stations will be specially designed to withstand and contain explosions following PRC regulations.

(iv) Gas regulation stations and the connection to the boilers will be equipped with flammable gas detection, alarm and fire suppression systems. Electrical devices within the explosion risk area will be safety equipped.

(v) Gas pipelines will be grounded and equipped with anti-lightning devices where applicable.

(vi) All other at risk areas will have flammable gas detection and alarm systems able generate audible and visual alarms, and automatic fire suppression systems.

(vii) All gas related devices will be brightly colored and equipped with warning signs.

[17] Gas regulation stations are defined as Class II explosion risks. Space within 4.5 meter away from a regulation station is included in the explosion risk region, as regulated in *Regulation on Electric Apparatus Design for Explosion and Fire Risk Environment* (GB50058-92). In the *Code for Design of City Gas* Engineering (GB 50028-2006) the recommended distance from a gas regulation station with no more than 1.6 MPa inlet pressure to other buildings is 12 m.

(viii) The nearby communities will be informed of the potential risks fire and explosion, and the emergency response plan.

245. To mitigate potential health and safety risks to workers, the following measures and good practice measures per the EHS Guidelines on occupational H&S will be taken:

(i) Operation phase EHS plan and traffic management plan will be developed and implemented and workers will be trained regularly on their implementation.

(ii) PPE including goggles, gloves, safety shoes will be provided to workers. Noise protection equipment will be provided to workers in high-noise area. Noise areas with more than 85 dB(A) shall be marked and hearing protections shall be provided to workers.

(iii) Noise level inside control room should be no more than 60 dBA.

(iv) Provide training to workers on occupational health and safety, and emergency response.

(v) Pipelines will be grounded and equipped with anti-lightning devices where applicable.

(vi) Vehicles transporting materials or wastes will slow down and not use their horn when passing through or nearby sensitive locations, such as residential communities, schools and hospitals.

(vii) Natural gas systems will be designed in strict compliance with relevant PRC fire, health and safety standards. Fire compartments will be established based on the fire risk, and fire-resistant buildings/structures will include fire-proof doors and windows.

(viii) Fire-alarm and suppression systems will be installed and tested regularly to ensure it functions properly.

(ix) Safe traffic control measures, including road signs and flag persons to warn of dangerous conditions will be taken as needed. Regular maintenance of vehicles to minimize potential accidents caused by equipment malfunction.

(x) Regular inspection and maintenance of pressure vessels and piping will be conducted. Adequate ventilation in work areas to reduce heat and humidity will be installed. Surfaces where workers come in close contact with hot equipment will be shielded. Warning sign will be placed in high temperature areas.

7. Emergency Response Plan

246. An emergency risk and response plan will be established in accordance with the “National Environmental Emergency Plan” (24 January 2006) and other relevant PRC laws, regulations and standards and will include measures in the World Bank EHS guidelines with respect to occupational and community health and safety. The main risks include potential fire and explosion hazards. Major elements of the emergency response plan are presented in **Table 2** of Appendix I.

D. Anticipated Positive Operation Phase Impacts

247. The component will deliver significant positive social impacts to beneficiaries through the delivery of heating by clean energy. The coal and emission reduction calculations of the

component are presented in **Table V-18** and **Table V-19.**

248. Instead of coal, the component will use a mix of cleaner heat sources such as waste heat and natural gas. When compared to the equivalent production of heat generation through traditional coal-fired sources, once operational, the component will: (i) result in annual energy savings equivalent to 1,157,368.0 tce, thereby providing a global public good by avoiding the annual emission of 3,054,491.8 tons of CO_2; (ii) improve local air quality through the estimated annual reduction of emissions of SO_2 by 3,649.5 tons, NOx by 3,638.1 tons, and PM by 609.8 tons; and (iii) eliminate the negative impacts of coal transportation through urban areas by truck or train.

Table V-18: Coal and emission reduction calculations

Item	Technology adopted	Heating area (million m^2)	Energy consumption	Total energy consumption	Energy consumption TCE (tons)
Component	Waste heat recovery	80	160.51 GWh[18]	34,280,314 m^3 natural gas 228.44 GWh	117,839.39[19]
	Air source heat pump	0.0502	54.22 GWh[20]		
	Gas-fired boilers	1.03	12,056,974 m^3 natural gas 1.34 GWh[21]		
	Gas-driven heat pump	1.4895	22,223,340 m^3 natural gas 13.72 GWh[22]		
Baseline	Coal based CHP	82.5697	NA	1,155,975.8 Tce 356.70 GWh [23]	1,275,207.37[24]
			Savings		1,157,367.98

[18] Based on operating experience of JTPC

[19] According to the China Power Sector Annual Development Report 2017 issued by CEC (China Electricity Council), coal-fired power plant above 6000Kw consumes 312gce to produce per kWh of electricity. Take 6.66% as the loss of transmission. Based on the heat value, per cubic meter of NG is converted to 1.21kgce

[20] Based on operating experience of JTPC, electricity consumption intensity of air source heat pumps is 0.108GWh/10,000 m^2/a.

[21] Based on operating experience of JTPC, gas-fired boiler consumes 117,058Nm³ of natural gas and 13MWh of electricity to provide heat for 10,000 square meters per year.

[22] Based on operating experience of JTPC, gas-driven heat pump consumes 14.92m³ of natural gas and 9.21kWh of electricity to provide heat for one square meter per year.

[23] Based on operating data of JTPC, in 2017-2018 heating season, coal consumption intensity was 0.014tce/m^2/a and electricity consumption intensity for CHP is 4.32kWh/m^2/a;

[24] Same as note 17.

Table V-19: Emission reduction calculations

Item	Total energy consumption	Pollutants emission (tons)			
		CO_2	SO_2	NOx	PM
Component	34,280,314 m^3 natural gas[25]	67, 189.4	3.7	11.2	1.0
	228.44 GWh[26]	165,690.6	89.1	82.2	18.3
Baseline	1,155,975.8 tce[27]	3,028,656.6	3,603.2	3,603.2	600.5
	356.70 GWh	258,715.3	139.1	128.4	28.5
Savings		3,054,491.8	3,649.5	3,638.1	609.8

[25] According to Environment Protect Practical Data Handbook, CO_2 emission is 1.96kg per m³of natural gas. Burning 1m³ natural gas produces 12.14m³ waste gas. And the emission calculation of Gas-driven heat pumps is based on the monitoring data SO_2: 9 mg/m^3; NOx: 27 9 mg/m^3; PM: 2.3mg/m^3);

[26] Based on the China Power Sector Annual Development Report 2017 issued by CEC (China Electricity Council), the PM, SO_2, and NOx emission factor of thermal power generation was 0.08, 0.39, and 0.36gce/kWh respectively in 2016. NDRC (National Development and Reform Commission) issues CO_2 emission per kWh every year for CDM project development. The carbon emission factor of North China Grid was 0.7253 t-CO_2/MWh in 2016. The loss of transmission is 6.66%.

[27] According to Air Pollutants Emission Standards for Boilers (GB13271-2014), the PM, SO_2, and NOx emission standard is 30mg/m³, 200 mg/m³, and 200 mg/m³respectively. Burning 1kg standard coal produces 9.6Nm³ waste gas, and produces 1.92 g SO_2, 1.92 g NOx and 0.288 g PM.

VI. ANALYSIS OF ALTERNATIVES

249. An analysis of component alternatives was undertaken during the feasibility stage to determine the most financially and technically feasible way of achieving the project objectives while minimizing environmental and social impacts.

A. No Project Alternative

250. Jinan, the capital of Shandong Province, is situated in the northeastern part of PRC. The winter temperature drops to as low as –19°C, and sub-zero temperatures typically last for 4 months a year; under this climate heating service is an essential requirement for sustaining people's livelihoods. Heat demand in Jinan is increasing substantially due to rapid ongoing urban expansion. Current district heating coverage in Jinan is approximately 147 million m^2, compared to 87.6 million m^2 in 2012.

251. The existing system in Jinan is a large scale district heating system driven by coal-fired heat source plants or CHP plants. However, the expansion of the existing coal-based district heating system to meet the increasing demand is not an option as Jinan has been experiencing significant pollution problems in the winter heating seasons including hazy skies and high levels of particulates.

252. Coal-based heating is the major cause of rising level of outdoor and indoor air pollution during the winter. According to PM source analysis result in Jinan in 2017 by Jinan EPB, 24.6% of $PM_{2.5}$ and 17.4% of PM_{10} are from coal combustion.

253. The component's implementation will: (i) fulfil rapidly increasing heat demand in west Jinan; (ii) significantly reduce coal consumption; (iii) improve air quality; and (iv) reduce GHG emissions. It will also provide valuable hands on experience and help to explore various uses of different energy sources like waste heat, natural gas and power source, which will support the development of sustainable energy system solutions for rapid urban development. For these reasons the "no project" alternative is considered unacceptable.

B. Energy Sources

254. There are several heat sources options for district heating, including CHP plants, large coal, natural gas or biomass-fired heat source plants (HSPs), solar energy, wind energy, industrial or residential waste heat, geothermal energy, and heat pumps.

255. CHPs and HSPs are considered the most proven, economically viable, energy efficient and environmentally friendly heat source options for northern China.

256. Based on No Project Alternative analysis, coal based CHPs and HSPs are not acceptable.

257. The component is located at urban area of Jinan, no biomass resource is available in a radius of 10 km. Therefore, biomass is not a good choice.

258. Annual average sunshine hours near the component site from 1997-2016 were 2,177.5 hours and is classified as middle level solar energy area. Therefore, solar power is not a good

choice.

259. Average wind speed near the component site from 1997-2016 were 1.9 m/s and is classified as middle level wind power area. Therefore, wind power is not a good choice.

260. Natural gas is the recommended fuel source in the World Bank Group's *Environmental Health and Safety (EHS) Guidelines*. Natural gas generally produces negligible quantities of particulate matter and sulfur oxides, and levels of nitrogen oxides are about 60% of those from plants using coal (without emission reduction measures). Natural gas-fired plants also release lower quantities of carbon dioxide, a greenhouse gas. Natural gas is the only fossil fuel applied in the project and will contribute to emissions reduction in Jinan. In addition, gas-fired facilities do not require large coal storage sheds or ash storage silos, and do not need water and electricity for coal, fly and bottom ash and slag treatment. Thus, the use of natural gas-fired instead of coal-fired boilers will require less land and will consume less water and electricity. Furthermore, the transmission of natural gas by pipeline will eliminate the negative impacts of coal transportation through urban areas by truck or train.

261. Because all the 29 communities will be connected to the district heating system, big natural gas fired boilers are not a good choice. The component has selected small gas fired boilers and small sets of gas driven heat pump units which are easier to be removed to another place.

262. Overall, the component has selected the most appropriate fuel type and heat sources.

C. Large temperature difference waste heat exchange technology

263. Waste heat is the cleanest source for heat supply, which only needs a small amount of electricity to transport the waste heat from the source industrial or power plant to the customers. There are many industrial waste heat sources around Jinan as shown in **Figure III-4**. The waste heat has limited utilization because of its relatively low temperature (below 150℃) and is referred to as low-heat value source, but its temperature is still higher enough for space heating. In the past decades, due to the considerable amount of heat loss for long-distance transport, only a very small amount of waste heat was used to supply heat to the customers who normally reside near to the heating sources. Most of the waste heat was exhausted to the atmosphere. As the material and insulation technology improved, long-distance heat transport is no longer an issue. A long-distance pipeline will be built to bring waste heat from Xinyuan Power Plant (6×600MW water-cooling gen-sets) and Haoji Power Plant (4×360MW water-cooling gen-sets) to west Jinan as marked red stars in **Figure III-4**. The waste heat will be the main source of district heating for the area in the near future. It will supply heat to about 80 million m^2 of buildings during winter season, with a design capacity of 3,440 MW. By 2020, west Jinan will achieve coal-free heat supply.

264. To improve the efficiency of the long-distance pipeline, "large temperature difference" technology is adopted for transporting waste heat to the city, which will increase the heat transport capacity for more than 50% using the same pipelines and same time reduce electricity consumption for cycling pumps.

265. Overall, the component has selected the most appropriate long distance heat transfer technology.

D. Pipeline Network

266. The component will utilize direct-buried pre-insulated bonded pipeline, which is by far the

most commonly used technology for both new district heating systems and for rehabilitation of existing systems. Steel pipes and insulation materials made of polyurethane foam and high density polyethylene are bonded into one piece in a sandwich-like structure. Compared to onsite insulated pipe buried in a tunnel, direct-buried pre-insulation bonded pipe has many advantages including lower capital costs, reduced heat losses and improved energy efficiency, better anti-corrosive and insulation performance, longer service life, limited land acquisition requirement and shorter installation cycles. Although pre-insulated bonded pipe is designed for direct-bury installation, some sections of pipeline may need to run overhead and/or use trench laying modes, depending on local site conditions.

267. The component will also install low temperature heat supply secondary networks. Pre-insulated plastic pipes will be directly buried, and twin-pipe can be utilized where both supply and return pipe can be inserted into one insulation jacket. Construction of secondary networks is easier when bendable plastic pipes are used.

E. Overall Alternative Analysis

268. Based on the analysis of alternatives, the component has selected the most appropriate and sustainable heat source, long distance heat transfer technology, pipeline type and waste heat utilization method.

VII. INFORMATION DISCLOSURE AND PUBLIC CONSULTATION

A. PRC and ADB Requirements for Disclosure and Public Consultation

1. PRC Requirements

269. Relevant provisions in the PRC *Environmental Impact Assessment Law* (revised in 2016) and the *Regulations on the Administration of Construction Project Environmental Protection* (No. 253 Order of the State Council, 1998, revised in 2017) require that an EIA study for a construction project shall solicit opinions from affected residents, as well as other organizations and concerned stakeholders. However, the requirements for public consultation are different for various sectors and projects. For an environmental Category A project a full EIA report is required including two rounds of public consultations, while for a Category B project only a simplified tabular EIA is required without the need for public consultation.

270. The "Provisional Regulations on Public Participation in Environmental Impact Assessment" (2006) promulgated by State Environmental Protection Administration further improved the legislation of public participation in EIA in China. It provides detailed requirements for the public participation process, including information disclosure standards, consultation methods, and public enquiry process. It is significant since it was the first document clearly regulating public participation in EIA in China.[28]

271. In 2014, former MEE released "Guiding Opinions on Promoting Public Participation in Environmental Protection" (2014, No. 48) which defines public participation as 'citizens, legal persons and other organizations' voluntary participation in environmental legislation, enforcement, judicature and law obedience, and the development, utilization, protection and transformation activities related to environment.

272. The public disclosure and consultation process undertaken during the preparation of the domestic EIA was undertaken in compliance with the relevant PRC requirements, including the "Provisional Regulations on Public Participation in Environmental Impact Assessment" (2006) and the "Guiding Opinions on Promoting Public Participation in Environmental Protection" (2014, No. 48).

2. ADB Requirements

273. ADB's SPS (2009) has specific requirements for information disclosure and public consultation. Information disclosure involves delivering information about a proposed project to the general public and to affected communities and other stakeholders, beginning early in the project cycle and continuing throughout the life of the project. Information disclosure is intended to facilitate constructive engagement with affected communities and stakeholders over the life of the project.

274. The SPS requires that borrowers take a proactive disclosure approach and provide relevant information from environmental assessment documentation directly to affected peoples and stakeholders. In addition, in order to make key documents widely available to the general public, the SPS requires submission to ADB for posting on the ADB website as follows:

28 Wang Ya Nan, 2012. Public Participation in EIA, SEA and Environmental Planning in China. Environmental Impact Assessment Research Centre.

(i) a draft full EIA (including the draft EMP) at least 120 days prior to ADB Board consideration for Category A projects, and/or environmental assessment and review frameworks before project appraisal, where applicable;
(ii) the final EIA/IEE;
(iii) a new or updated EIA/IEE, EMP and corrective action plan prepared during project implementation, if any; and
(iv) environmental monitoring reports.

275. The SPS also requires that the borrower carry out meaningful consultation with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation. Consultations should include presentations on environmental impacts, benefits and mitigation measures, the project GRM, and ADB's Accountability Mechanism. For category A projects, such consultations should include consultations both at an early stage of EIA field work and when the draft EIA report is available.

B. Project Information Disclosure

276. Domestic EIA Institute has undertaken two rounds of information disclosure in accordance with the Interim Guidelines on Public Consultation for EIA (2006) during domestic EIA process of the pipeline..

1. Information Disclosure by EIA Institute

277. IA disclosed the information of the component in two steps. The first public information notice was posted on the Jinan EPB's website in July 2018, after in the domestic EIA was submitted to Jinan EPB. The information in the first public notification (The link is http://jnepb.jinan.gov.cn/art/2018/7/18/art_10432_2130692.html) is listed below:

(i) Name and summary of the component.
(ii) Name and contact information of the construction company.
(iii) Name and contact information of the institute responsible for preparing the EIA of the component.
(iv) EIA procedures and content.
(v) Type of EIA notification notice.
(vi) Request for questions, suggestions and feedback from the public.

278. A second public information notice was also posted on the Jinan EPB's website from August 13 to August 21, 2018, prior to the approval of the draft EIA report to the Jinan EPB. The link is http://jnepb.jinan.gov.cn/art/2018/8/13/art_10495_2436870.html. The notice included Project name and information below:

(i) Name and summary of the component.
(ii) Name and contact information of the institute responsible for preparing the EIA report.
(iii) Name and contact information of the institute responsible for approval of the EIA report.
(iv) Name and contact information of the construction company.
(v) Potential project environmental impacts and mitigation measures during construction phase and operation phase.

(vi) Key conclusions of the EIA report.
(vii) Contact information to get abridged versions of the EIA report.

Figure VII-1: Information disclosure on Jinan EPB's website.

济南市环境保护局局关于受理《济南热电有限公司2018年城市道路配套热力管网工程项目环境影响报告表》的公示

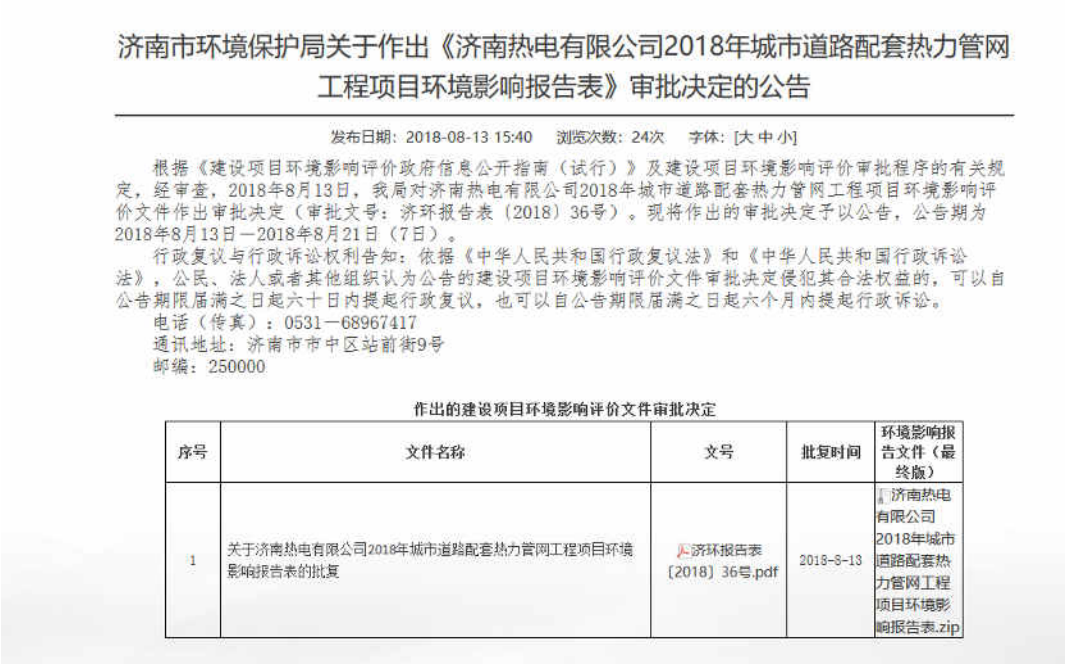
发布日期：2018-07-18 08:33　浏览次数：41次　字体：[大 中 小]

根据《建设项目环境影响评价政府信息公开指南（试行）》及建设项目环境影响评价审批程序的有关规定，我局于2018年7月18日受理了济南热电有限公司2018年城市道路配套热力管网工程项目环境影响评价报告表，现将受理情况予以公示，公示期为2018年7月18日—2018年7月20日（3个工作日）。

联系电话（传真）：0531-68967417（行政审批大厅）
通讯地址：济南市市中区站前街9号
邮　　编：250000

序号	项目名称	建设地点	建设单位	环境影响评价机构	受理日期
1	2018年城市道路配套热力管网工程项目[济南热电有限公司2018年城市道路配套热力管网工程项目.rar	济南市	济南热电有限公司	山东环保产业集团有限公司	2018-07-18

(i) First information disclosure



济南市环境保护局关于作出《济南热电有限公司2018年城市道路配套热力管网工程项目环境影响报告表》审批决定的公告

发布日期：2018-08-13 15:40　浏览次数：24次　字体：[大 中 小]

根据《建设项目环境影响评价政府信息公开指南（试行）》及建设项目环境影响评价审批程序的有关规定，经审查，2018年8月13日，我局对济南热电有限公司2018年城市道路配套热力管网工程项目环境影响评价文件作出审批决定（审批文号：济环报告表（2018）36号）。现将作出的审批决定予以公告，公告期为2018年8月13日—2018年8月21日（7日）。

行政复议与行政诉讼权利告知：依据《中华人民共和国行政复议法》和《中华人民共和国行政诉讼法》，公民、法人或者其他组织认为公告的建设项目环境影响评价文件审批决定侵犯其合法权益的，可以自公告期限届满之日起六十日内提起行政复议，也可以自公告期限届满之日起六个月内提起行政诉讼。

电话（传真）：0531—68967417
通讯地址：济南市市中区站前街9号
邮编：250000

作出的建设项目环境影响评价文件审批决定

序号	文件名称	文号	批复时间	环境影响报告文件（最终版）
1	关于济南热电有限公司2018年城市道路配套热力管网工程项目环境影响报告表的批复	济环报告表〔2018〕36号.pdf	2018-8-13	济南热电有限公司2018年城市道路配套热力管网工程项目环境影响报告表.zip

(ii) Second information disclosure

279. No public feedback was received during two rounds of public information disclosure. When separate EIAs is beings prepared, all the EIAs will follow the same public information disclosure process.

280. This IEE prepared will be disclosed on the JTPC's website and ADB website. Two rounds of information disclosure have been implemented by the JTPC.

2. Public Consultation

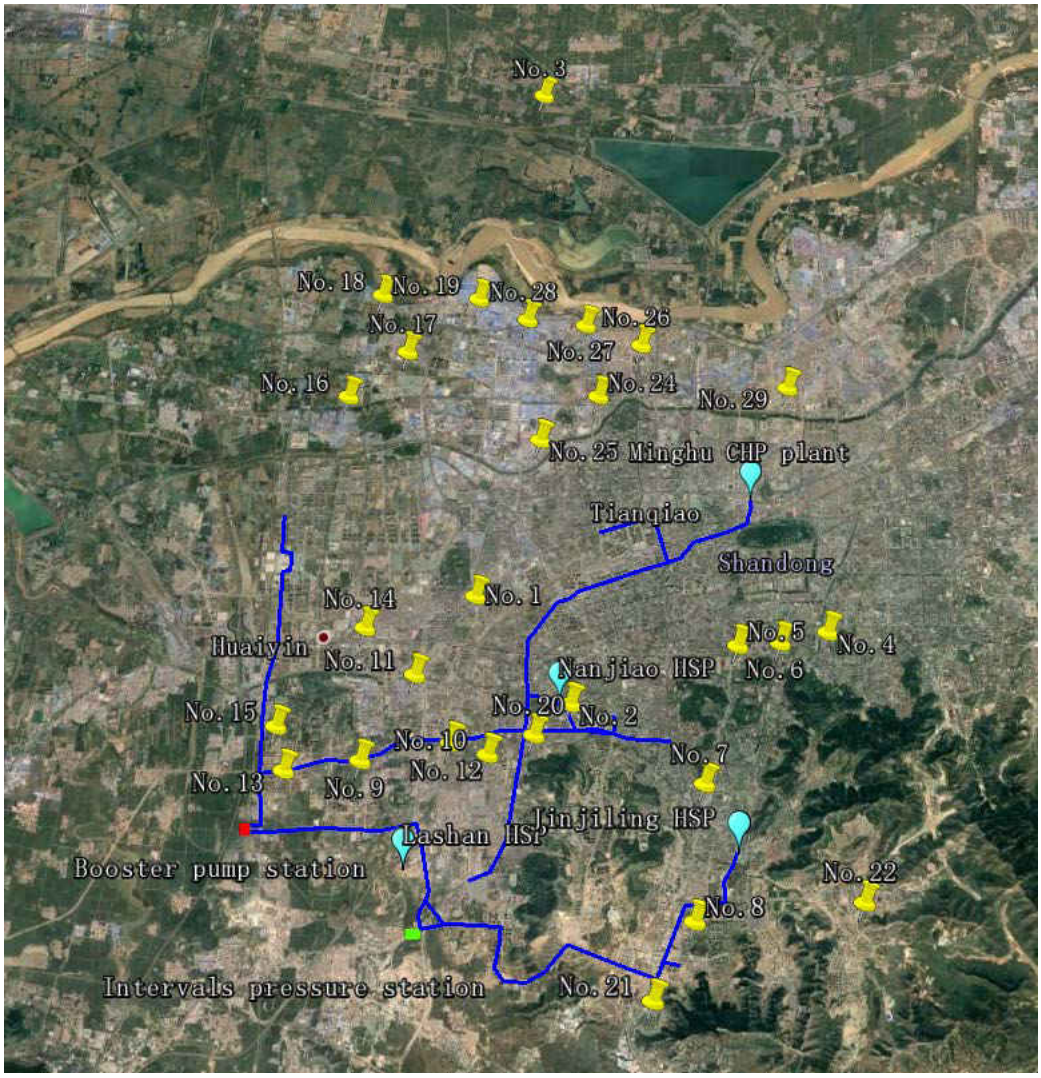
281. As part of the social safeguards due diligence undertaken for the component by ADB PPTA team, a social analysis was undertaken to (i) assess social patterns influenced by the component including the identification of any adverse effects; (ii) assess the current status of poverty within the heating areas and analyzed the poverty reduction impact resulting from the Project; and (iii) analyze and proposes activities which would complement the Project by enhancing the livelihood of the vulnerable people within the heating area of the component.

282. The methodology for the social analysis included socioeconomic surveys (carried out from March – April 2018) and local consultations. The consultants visited all heating areas and held meetings with the IA and local people and various district government agencies including the development and reform committees, land administration bureaus, civil affairs bureaus, urban construction bureaus and women's federations, etc.

283. The social analysis results are presented in the social analysis report.

284. Considering the 29 separate communities, the JTPC held five separate public consultation meeting from March – April 2018 during the preparation of the IEE. Five public consultation meetings were held in No. 17 community (residents from No.3 community are invited to No.17 community), and meeting rooms of Lashan HSP, Jinjiling HSP, Minghu HSP and Nanjiao HSP. The locations of the five public consultation meetings are presented in **Figure VII-3**.

Figure VII-2: Public consultation activities locations



285. A public project information notice was posted in the nearby communities for two weeks prior to the meetings. Nearby residents were invited to the meetings. During the meetings, information on the component construction content and status was presented by JTPC while information on potential environmental impacts and proposed mitigation measures, GRM requirements of ADB and component benefits was presented by social consultant and environmental consultant. Then questions and subsequent discussions focused on environmental issues of the component and benefits of the component especially clean district heating and employment promotion. During the meetings, most of the participants believed that the component can provide a clean district heating service and provide more job opportunities to the nearby communities and 100% of participants supported the construction of component.

286. During the public consultant meetings, a total of 121 questionnaires (**Table VII-1**) were distributed and 121 completed questionnaires were received. The main contents of the questionnaire are potential impacts and mitigation measures. Completed questionnaires and some photos of the consultation meeting and survey are shown in **Figure VII-3**.

287. During the social survey, the same questionnaires were also distributed. In the social survey, 82 were distributed and 82 completed questionnaires were received.

288. **Table VII-2** presents summary data on the questionnaire respondents, while **Table VII-3** presents a summary of the questionnaire results.

Figure VII-3: Public consultation activities

(i) Meeting in Jinjiling HSP.

(ii) Meeting in Nanjiao HSP.

(iii) Meeting in Minghu HSP.

(iv) Meeting in Lashan HSP.

(v) Meeting in No. 17 community

(vi) Questionnaire fill up

(vi) Completed questionnaires

289. Most of the respondents work and live within a 5 km radius of the component; 53.7% of respondents knew about project either from other persons, newspapers or information signs, and 91.1% of respondents indicated that they were already familiar with the project benefits after the introduction of the project. 40.9% of the participants were female. The top three environment issues respondents identified in their neighborhoods are air quality (66.5%), noise (41.9%) and surface water (17.7%). Dust and noise were identified as the top two issues during the construction phase. Air pollution and noise were identified as the top two issues during the operation phase. However, most participants also indicated that potential air, waste water, solid waste and noise impacts can be appropriately mitigated.

290. Overall support for the project is very strong; 83.7% of the respondents indicated that the project will improve local economic development; 92.6% indicated that the project will improve quality of life; and 93.6% of respondents indicated that they support the proposed project.

Table VII-1: Project public consultation questionnaire (2018)

Name		Sex		Age	
Education level		Occupation		Nationality	
Contact information					
Question		**Choices**		**Yes**	**Comments**
1. In your opinion, what are the major environment pollution issues in your areas?		Ambient air			
		Noise			
		Surface water			
		Ground water			
		Soil			
		Solid waste			
		Odor			
		Risks associated with chemicals and hazardous chemicals			
		Other concern			
2. Distance between your working place and project site		<1 km			
		1-3 km			
		3-5 km			
		> 5km			
3. Distance between your house and project site		<1 km			
		1-3 km			
		3-5 km			

	> 5km		
4. Do you know this project before this public consultation?	Yes		
	No		
5. Do you understand environment impacts of this project before this public consultation?	Yes		
	No		
	Not clear		
6. After knowing about the EIA findings, are all the potential positive and adverse impacts of the proposed project components clear to you?	Clearly understand		
	Somewhat understand		
	Barely understand		
	Do not understand		
7. In your opinion, what should be the most critical area that the project should focus on?	Exhaust air efficiency treatment		
	Controlling fugitive emissions		
	Wastewater treatment		
	Groundwater protection		
	Soil protection		
	Chemicals handling		
	Odor control		
	Make use of recyclable resources to reduce solid waste		
	Noise disturbing to residents		
	Protection for community health and safety		
	Protection to workers health and safety		
	Others		
8. Do you understand the potential adverse impacts during the construction of the proposed project components?	Clearly understand		
	Somewhat understand		
	Barely understand		
	Do not understand		
9. What do you think about the project construction? Do you think it is necessary?	Necessary		
	Barely necessary		
	Not necessary		
	It does not matter		
10. What would be the major impacts during project construction?	Noise		
	Dust		
	Solid waste		
	Traffic congestion		
	Others		
	No major impacts		
11. Without mitigation measures, do you accept anticipated construction phase impacts?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
12. After learning about mitigation measures during the construction, do you accept anticipated construction phase impacts?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
13. Do you agree with project construction after comprehensive consideration?	Yes		
	No		
	I do not know		
14. Do you understand all the anticipated environmental	Clearly understand		
	Somewhat understand		

adverse impacts of the project during operation?	Barely understand		
	Do not understand		
15. Do you understand all the anticipated health and safety adverse impacts of the project during operation?	Clearly understand		
	Somewhat understand		
	Barely understand		
	Do not understand		
16. Do you understand the proposed mitigation measures during the project operation?	Clearly understand		
	Somewhat understand		
	Barely understand		
	Do not understand		
17. Do you accept the impacts to ambient air quality by this project?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
18. Do you accept the impacts to surface water quality by this project?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
19. Do you accept the impacts to ground water quality by this project?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
20. Do you accept the impacts to acoustic environment quality by this project?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
21. Do you accept the solid waste pollution by this project?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
22. Do you accept the impacts to ecological environment by this project?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
23. Do you accept environment, health, and safety risks caused by this project?	Accept		
	Barely accept		
	Do not accept		
	Have no idea		
24. What are the major concerns of this project	Ambient air		
	Noise		
	Surface water		
	Ground water		
	Soil		
	Solid waste		
	Odor		
	Risks associated with chemicals and hazardous chemicals		
	Other concern		
25. Which is your top concern of this project?	Ambient air		
	Noise		
	Surface water		
	Ground water		
	Soil		
	Solid waste		

	Odor		
	Risks associated with chemicals and hazardous chemicals		
	Other concern		
26. Do you think construction of this project can improve local economic development or not?	Yes		
	No		
	I do not know		
27. Do you think whether construction of this project can improve your living quality such as better hear supply service?	Yes		
	No		
	I do not know		
28. Do you support the project?	Yes		
	No		
	I do not know		
Suggestions or requirements for environment protection of the project.			

Table VII-2: Summary data on questionnaire respondents

Parameter	Indicator	No.	%
Sex	Male	120	59.1%
	Female	83	40.9%
Age	Below 30	28	13.8%
	31-40	62	30.5%
	41-50	75	36.9%
	Above 50	38	18.7%
Nationality	Han people	198	97.5%
	Other	5	2.5%
Education Level	Primary School or Below	22	10.8%
	Junior school	47	23.2%
	High school, including technical secondary school	85	41.9%
	Bachelor degree or above, including junior college	49	24.1%
Occupation	Farmer	58	28.6%
	Employee	112	55.2%

	Civil servant	18	8.9%
	Other	15	7.4%

Table VII-3: Public consultation questionnaire results.

Question	Item	No.	% (shading denotes highest ranked)
1. In your opinion, what are the major environment pollution issues in your areas?	Ambient air	135	66.5%
	Noise	85	41.9%
	Surface water	36	17.7%
	Ground water	17	8.4%
	Soil	8	3.9%
	Solid waste	22	10.8%
	Odor	0	0.0%
	Risks associated with chemicals and hazardous chemicals	0	0.0%
	Other concern	0	0.0%
2. Distance between your working place and project site	<1 km	28	13.8%
	1-3 km	68	33.5%
	3-5 km	75	36.9%
	> 5km	32	15.8%
3. Distance between your house and project site	<1 km	102	50.2%
	1-3 km	65	32.0%
	3-5 km	22	10.8%
	> 5km	14	6.9%
4. Do you know this project before this public consultation?	Yes	109	53.7%
	No	94	46.3%
5. Do you understand environment impacts of this project before this public consultation?	Yes	65	32.0%
	No	55	27.1%

	Not clear	83	40.9%
6. After this public consultation, are all the potential positive and adverse impacts of the proposed project components clear to you?	Clearly understand	145	71.4%
	Somewhat understand	17	8.4%
	Barely understand	23	11.3%
	Do not understand	18	8.9%
7. In your opinion, what should be the most critical area that the project should focus on?	Exhaust air efficiency treatment	104	51.2%
	Controlling fugitive emissions	48	23.6%
	Wastewater treatment	41	20.2%
	Groundwater protection	29	14.3%
	Soil protection	21	10.3%
	Chemicals handling	13	6.4%
	Odor control	12	5.9%
	Make use of recyclable resources to reduce solid waste	34	16.7%
	Noise disturbing to residents	78	38.4%
	Protection for community health and safety	34	16.7%
	Protection to workers health and safety	29	14.3%
	Others	0	0.0%
8. Do you understand the potential adverse impacts during the construction of the proposed project?	Clearly understand	130	64.0%
	Somewhat understand	35	17.2%
	Barely understand	27	13.3%
	Do not understand	11	5.4%
9. What do you think about the project construction? Do you think it is necessary?	Necessary	140	69.0%
	Barely necessary	33	16.3%
	Not necessary	8	3.9%
	It does not matter	22	10.8%
10. What would be the major impacts during project construction?	Noise	74	36.5%
	Dust	61	30.0%

	Solid waste	32	15.8%
	Traffic congestion	30	14.8%
	Others	0	0.0%
	No major impacts	6	3.0%
11. Without mitigation measures, do you accept anticipated construction phase impacts?	Accept	139	68.5%
	Barely accept	44	21.7%
	Do not accept	6	3.0%
	Have no idea	14	6.9%
12. After learning about mitigation measures during the construction, do you accept anticipated construction phase impacts?	Accept	152	74.9%
	Barely accept	34	16.7%
	Do not accept	6	3.0%
	Have no idea	11	5.4%
13. Do you agree with project construction after comprehensive consideration?	Yes	167	82.3%
	No	14	6.9%
	I do not know	22	10.8%
14. Do you understand all the anticipated environmental adverse impacts of the project during operation?	Clearly understand	93	45.8%
	Somewhat understand	56	27.6%
	Barely understand	33	16.3%
	Do not understand	21	10.3%
15. Do you understand all the anticipated health and safety adverse impacts of the project during operation?	Clearly understand	117	57.6%
	Somewhat understand	33	16.3%
	Barely understand	38	18.7%
	Do not understand	15	7.4%
16. Do you understand the proposed mitigation measures during the project operation?	Clearly understand	124	61.1%
	Somewhat understand	43	21.2%
	Barely understand	22	10.8%
	Do not understand	14	6.9%

17. Do you accept the impacts to ambient air quality by this project?	Accept	87	42.9%
	Barely accept	72	35.5%
	Do not accept	12	5.9%
	Have no idea	32	15.8%
18. Do you accept the impacts to surface water quality by this project?	Accept	107	52.7%
	Barely accept	46	22.7%
	Do not accept	14	6.9%
	Have no idea	36	17.7%
19. Do you accept the impacts to ground water quality by this project?	Accept	133	65.5%
	Barely accept	41	20.2%
	Do not accept	10	4.9%
	Have no idea	19	9.4%
20. Do you accept the impacts to acoustic environment quality by this project?	Accept	87	42.9%
	Barely accept	49	24.1%
	Do not accept	23	11.3%
	Have no idea	44	21.7%
21. Do you accept the solid waste pollution by this project?	Accept	114	56.2%
	Barely accept	38	18.7%
	Do not accept	9	4.4%
	Have no idea	42	20.7%
22. Do you accept the impacts to ecological environment by this project?	Accept	99	48.8%
	Barely accept	57	28.1%
	Do not accept	18	8.9%
	Have no idea	29	14.3%
23. Do you accept environment, health, and safety risks caused by this project?	Accept	121	59.6%
	Barely accept	46	22.7%
	Do not accept	20	9.9%

	Have no idea	16	7.9%
24. What are the major concerns of this project	Ambient air	68	33.5%
	Noise	46	22.7%
	Surface water	23	11.3%
	Ground water	13	6.4%
	Soil	16	7.9%
	Solid waste	19	9.4%
	Odor	5	2.5%
	Risks associated with chemicals and hazardous chemicals	13	6.4%
	Other concern	0	0.0%
25. Which is your top concern of this project?	Ambient air	77	37.9%
	Noise	58	28.6%
	Surface water	13	6.4%
	Ground water	8	3.9%
	Soil	12	5.9%
	Solid waste	25	12.3%
	Odor	3	1.5%
	Risks associated with chemicals and hazardous chemicals	7	3.4%
	Other concern	0	0.0%
26. Do you think construction of this project can improve local economic development or not?	Yes	170	83.7%
	No	17	8.4%
	I do not know	16	7.9%
27. Do you think whether construction of this project can improve your living quality such as better hear supply service?	Yes	188	92.6%
	No	0	0.0%
	I do not know	15	7.4%
28. Do you support the project?	Yes	190	93.6%
	No	0	0.0%

	I do not know	13	6.4%

C. Future Consultation Activities

291. This IEE will be disclosed on the ADB website. Any update in the IEE resulting from a change in project scope will be similarly disclosed.

292. The IA will continue to conduct regular community liaison activities during the construction and operations phases, including the implementation of the GRM (see Chapter VIII). Ongoing consultation will ensure that public concerns are understood and dealt with in a timely manner.

VIII. GRIEVANCE REDRESS MECHANISM

A. Introduction

293. A project grievance can be defined as an actual or perceived project related problem that gives ground for complaint by an affected person (AP). As a general policy, a PMO will be established by IA and it will work proactively toward preventing grievances through the implementation of mitigation measures and community liaison activities that anticipate and address potential issues before they become grievances. In addition, as the project has strong public support and will not involve any involuntary land or property acquisition or resettlement, significant grievance are unlikely to happen. Nonetheless, during construction and operation it is possible that unanticipated impacts may occur if the mitigation measures are not properly implemented, or unforeseen issues arise. In order to address complaints if or when they arise, a component-level GRM has been developed in accordance with ADB requirements. A GRM is a systematic process for receiving, recording, evaluating and addressing AP's project-related grievances transparently and in a reasonable timeframe.

B. ADB's GRM Requirements

294. The ADB's SPS 2009 requires a project to establish a GRM to receive and facilitate resolution of AP's concerns and complaints about the project's environmental performance during construction as well as operation phases of the project. The GRM should be scaled to the risks and adverse impacts of the project; should address affected people's concerns and complaints promptly, using an understandable and transparent process; should be readily accessible to the community at no cost and without retribution; and, should not impede access to the PRC's judicial or administrative remedies.

C. Current GRM Practices in the PRC

295. At the national level, a framework to address grievance has been established. State Council Decree No. 431 "Regulations on Letters and Visits" (January 2005) establishes a complaint mechanism at all levels of government, and safeguards the complainants from any retaliation. The former MEP Decree No. 34 "Environmental Letters and Visits System" provides specific guidelines to establish a system and address environmental complaints. When APs are affected by project activities, they may complain to the contractors and the project company by themselves or through their community organizations, or complain directly to local EPBs. If the issue is not resolved they may take legal action, though that is typically considered as a last option.

D. Project Level GRM

296. The objective of the component GRM is to prevent and address community concerns, reduce risks, and assist the project to maximize environmental and social benefits. In addition to serving as a platform to resolve grievances, the sub-project level GRM has been designed to (i) open channels for effective communication, including the identification of new environmental issues of concern arising from the component; (ii) demonstrate concern about community members and their environmental well-being; and (iii) prevent and mitigate any adverse environmental impacts on communities caused by component implementation and operations. The GRM will be accessible to all members of the community through public information disclosure at IA's website, project site and community center, etc.

297. The overall approach of the GRM is to deal with grievances at a local level first in an efficient manner and escalate to higher level of authority if the grievance cannot be resolved. The designated person from the PMO will be responsible for implementation of the GRM. The PMO will be the key contact point for residents, businesses, government departments and other stakeholders who may require information about the component or who have an issue they would like to discuss.

298. The GRM will be implemented through five escalating steps, advancing to the next level only if the grievance was unable to be redressed at the previous level.

(i) **Step 1**: If a concern arises, the AP can try to resolve the issue of concern either directly with the contractor or with the contactor via GRM access points (community leaders, neighborhood organizations, PMO, local EPB) during the construction phase, and/or the operator during the operation phase. If the concern is resolved successfully no further follow-up action is required. Nonetheless, the contractor (during construction) and/or the operator (during operation) shall record any complaint and actions taken to resolve the issues and report the results to the PMO and the AP. If no solution is found within 10 working days or if the AP is not satisfied with the suggested solution under Step 1, proceed to Step 2. The AP may also skip Step 1 and directly file the complaint with the PMO.

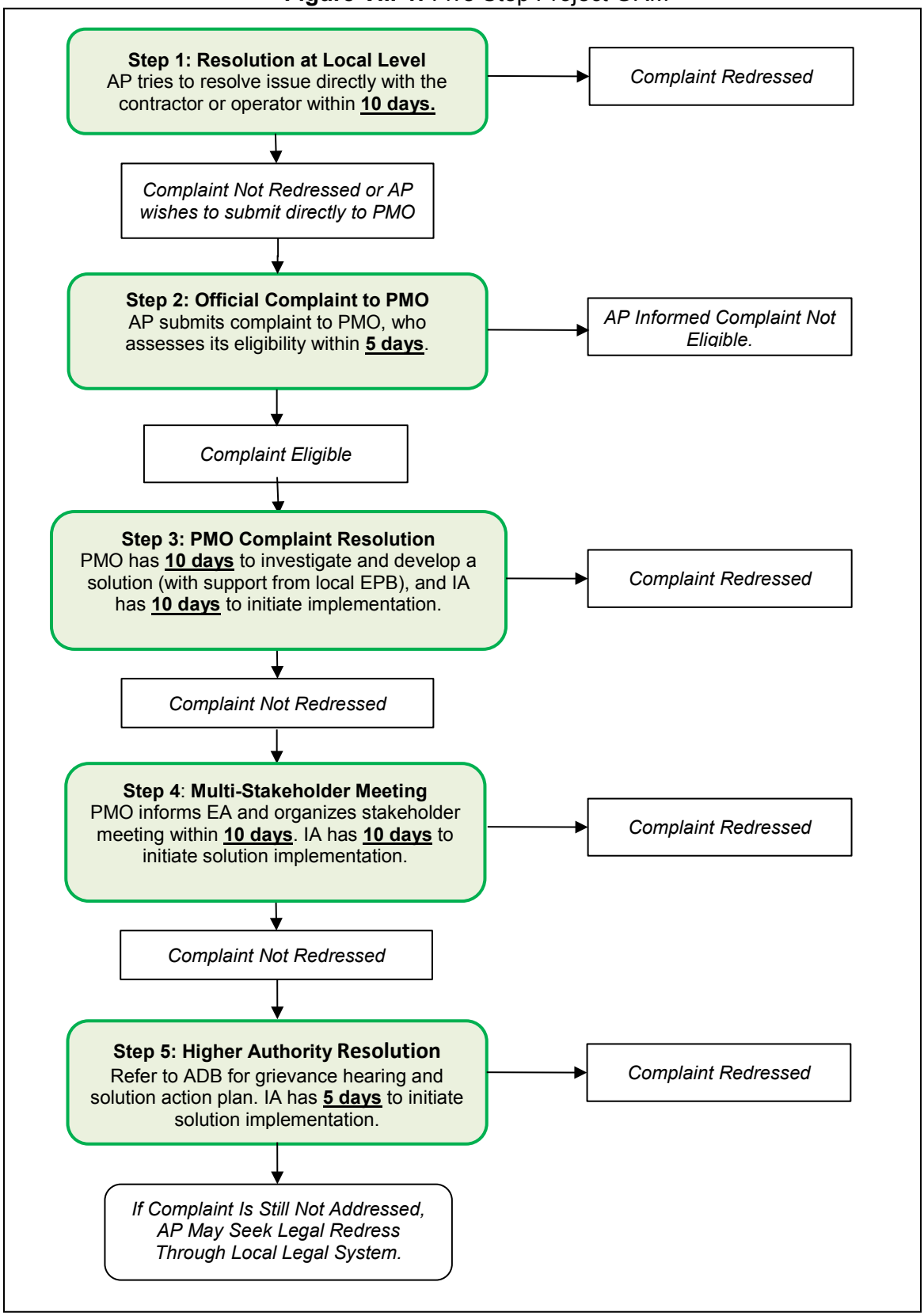
(ii) **Step 2:** The AP will submit the grievance to the PMO, who will record the grievance, assess its eligibility and report back to the AP within 5 working days. If the grievance is eligible, proceed to Step 3.

(iii) **Step 3:** The PMO will investigate the complaint, and consult with the IA, local EPB, and other stakeholders as appropriate to identify a solution. The PMO will give a clear reply to the AP within 10 working days with the suggested solution, and the IA will ensure that implementation of the agreed-upon redress solution begins within 10 working days. If no solution is found or if the complainant is not satisfied with the suggested solution under Step 3, proceed to Step 4.

(iv) **Step 4:** The PMO will inform the EA the grievance and will organize a multi-stakeholder meeting within 10 days, where all relevant stakeholders, including the complainant, EA, IA, and local EPB, can discuss the issue. The multi-stakeholder meeting will aim to find a solution acceptable to all and identify responsibilities and an action plan. The IA will ensure that the implementation of agreed-upon redress solution begins within 10 working days of the completion of the multi-stakeholder meeting.

(v) **Step 5:** If the complainant is still not satisfied with the suggested solution under Step 4, the grievance will be directed to ADB. ADB will direct the EA to organize a hearing process and shall determine a solution acceptable to all. Based on the hearing results, an action plan shall be developed and the IA will ensure that the implementation of the agreed-upon redress solution begins within 5 working days of the completion of the hearing.

Figure VIII-1: Five Step Project GRM



IX. CONCLUSIONS

299. This Initial Environmental Examination (IEE) report has been prepared for the proposed West Jinan Waste Heat Utilization and Clean Energy Component of the Shandong Clean Heating and Cooling Project (the Project) in Shandong Province of the PRC. The proposed Project is the fourth in a multi-year multi-sectoral ADB support for air quality improvement in the greater BTH region.

300. This component will: (i) install district heating network in west Jinan utilizing industrial waste heat as the main heat source to reduce coal use with a district heating of 80 million m^2. The industrial waste heat is from Xinyuan Power Plant (6×600MW water-cooling gen-sets) and Haoji Power Plant (4×360MW water-cooling gen-sets) and transferred through long-distance pipelines to transmit hot water recovered from the waste heat; (ii) provide district heating to 29 communities which are not connected to the district heating pipeline network by gas-driven heat pumps, gas-fired boilers and air source heat pumps. The total heating area is 2.5697 million m^2. The component will reduce coal combustion for urban heating, contributing to better air quality in Jinan City.

301. The component scope includes: (i) 1x1.5MW, 1x3.5MW, 4x2.8MW, 2x10.5MW and 3x7MW gas fired boilers to provide heating to an area of 1,030,000 m^2; (ii) 40 air source heat pump units to provide heating to an area of 50,200 m^2; (iii) 1,311 gas-driven heat pump units to provide heating to an area of 1,489,500 m^2 and (iv) 93.568 km of primary district heating network to provide district heating to 80 million m^2 in west Jinan by industrial waste heat. Once completed, the component will provide district heating to an area of 82,569,700 m^2.

302. The component will bring significant positive environmental benefits. It will reduce the emission of greenhouse gases and other air pollutants in Jinan City. When compared to equivalent heat generation through traditional coal-fired sources. Once operational the component will: (i) result in annual energy savings equivalent to 1,157,368.0 tce, thereby providing a global public good by avoiding the annual emission of 3,054,491.8 tons of CO_2; (ii) improve local air quality through the estimated annual reduction of emissions of SO_2 by 3,649.5 tons, NOx by 3,638.1 tons, and PM by 609.8 tons; and (iii) eliminate the negative impacts of coal transportation through urban areas by truck or train.

303. The component has: (i) selected appropriate technologies to reduce the emission of pollutants; (ii) identified potential negative environment impacts and appropriately established mitigation measures; (iii) received public support from the project beneficiaries and affected people; (iv) established effective project GRM procedures; and (v) prepared a comprehensive EMP including environmental management and supervision structure, environmental mitigation and monitoring plans, and capacity building and training.

304. It is concluded that the project will not result in adverse environmental impacts that are irreversible, diverse, or unprecedented. Any minimal adverse environmental impacts associated with the project will be prevented, reduced, or minimized through the implementation of the project EMP.

Appendices

Appendix I: Environmental Management Plan

Appendix II: Associated Facility Due Diligence Environmental Review – Xinyuan Power Plant

Appendix III: Associated Facility Due Diligence Environmental Review – Haoji Thermal Power Plant

APPENDIX I: ENVIRONMENTAL MANAGEMENT PLAN

A. Objectives

1. This EMP is for West Jinan Waste Heat Utilization and Clean Energy Component of the proposed Shandong Clean Heating and Cooling Project in Shandong Province of the PRC. The proposed project is the fourth in a multi-year multi-sectoral ADB support for air quality improvement in the greater BTH region.

2. This component will: (i) install district heating network in west Jinan utilizing industrial waste heat as the main heat source to reduce coal use with a district heating of 80 million m^2. The industrial waste heat is from Xinyuan Power Plant (6×600MW water-cooling gen-sets) and Haoji Power Plant (4×360MW water-cooling gen-sets) and transferred through long-distance pipelines to transmit hot water recovered from the waste heat; (ii) provide district heating to 29 communities which are not connected to the district heating pipeline network by gas-driven heat pumps, gas-fired boilers and air source heat pumps. The total heating area is 2.5697 million m^2. The component will reduce coal combustion for urban heating, contributing to better air quality in Jinan City.

3. The component will be implemented through three outputs:

   i) **Output 1**: Provide district heating to 29 communities which are not connected to the district heating pipeline network by gas-driven heat pumps, gas-fired boilers and air source heat pumps. Total heating area of the component will be 2,569,700 m^2.

   ii) **Output 2**: 93.568 km of primary district heating pipeline network will be constructed to provide district heating to 80 million m^2 in west Jinan by industrial waste heat. The pipe networks will utilize two-pipe system. One is water supply pipe and another is water return pipe; and

   iii) **Output 3**: Strengthened capacity to install and maintain clean heating technologies.

4. The objectives of the EMP are to ensure (i) implementation of the identified mitigation and management measures to avoid, reduce, mitigate, and compensate for anticipated adverse environment impacts; (ii) implementation of monitoring and reporting; and (iii) the component compliance with the PRC's relevant environmental laws, standards and regulations and ADB's SPS 2009. Organizational responsibilities and budgets are clearly identified for implementation, monitoring and reporting.

5. The EMP is to be implemented in all phases of the project cycle, including design, pre-construction, construction, and operation. In the detailed design stage, the EMP will be used by the design institute for incorporating mitigation measures into the detailed designs. The EMP will be updated at the end of the detailed design, as needed.

6. The EMP will be included as a separate annex in all bidding and contract documents. The

contractors will be informed of their obligations to implement the EMP, and to provide for EMP implementation costs in their bids for project works.

B. Implementation Arrangements

7. SPG will be the EA and responsible for overall guidance during project preparation and implementation. JTPC, a state-owned company will be the IA of the component and responsible for implementing project components and administering and monitoring contractors and suppliers. A PMO led by the Jinan Municipal Bureau of Housing and Urban-rural Development will be responsible for day-to-day management of the project.

8. The IA will implement project components, administer and monitor contractors and suppliers, and be responsible for construction supervision and quality control. The IA will ensure that the EMP is implemented proactively and responds to any adverse impact beyond those foreseen in the IEE. The IA will also attend to requests from relevant agencies and ADB regarding the mitigation measures and monitoring program. It will nominate dedicated, trained, and qualified environment specialists to (i) supervise contractors and ensure compliance with the EMP; (ii) conduct regular site inspections; (iii) conduct periodic environmental quality monitoring in compliance with the approved monitoring plan; (iv) act as local entry point for the project GRM; and (v) submit environmental monitoring reports to the EA and ADB semi-annually during construction and annually during operation. The IA will also appoint a Project Management Office Environment and Safety Officer (PMO ESO) and engage a local EMS for environmental monitoring.

9. Jinan Municipal Bureau of Housing and Urban-rural Development will establish a PMO, which will be responsible for day-to-day management of the project. The PMO will designate a qualified Environment Safeguard Officer (ESO), who will take overall responsibility for supervising the implementation of environmental mitigation measures, coordinating the project level GRM and preparing monitoring reports for submission by the PMO to ADB. The PMO ESO with support of the LIEC will (i) provide overall coordination and support on environmental aspects; (ii) supervise contractors and construction supervision companies (CSCs) and their compliance with the EMP; (iii) conduct regular site compliance inspections; (iv) act as PMO entry point for the project GRM; (v) collect and submit environmental monitoring data provided by (a) contractors and/or CSCs to the PMO, and (b) the EMS to the PMO; and (vi) support PMO with preparation of EMP progress section as a part of semiannual project progress reports and semiannual environmental monitoring reports (EMRs). The IA will be responsible for implementing the operational EMP.

10. The PMO will engage a LIEC, a part-time national environmental, health, and safety specialist prior to the engagement of construction contractors and the project construction, who will support the PMO in mitigation implementation, environmental monitoring, reporting, and addressing any environment-related issues that arise including grievances. The LIEC will also support contractors in developing construction site-specific environmental management plans (CEMPs) prior to construction and operation.

11. A local EMS will be engaged by the IA to undertake construction and operation phase ambient environmental monitoring, as per the requirements of the environmental monitoring plan (EMoP) presented in this EMP.

12. Construction contractors will be responsible for implementing the mitigation measures during construction under supervision of the IA and the PMO. In their bids, the contractors will prepare CEMPs which detail how the contractors will comply with the EMP. Each contractor will

identify a lead focal point for environmental issues (e.g., Environment, Health and Safety Officer), who will oversee CEMP implementation, take all reasonable measures to minimize the impact of construction activities on the environment, develop and prepare monthly reports for submission to the IA. Contractors are also required to report any spills, accidents, and grievances received, and take appropriate action. The Environment, Health and Safety Officer will also be responsible for developing CEMPs and an Occupational Health and Safety Plan (OHSP).

13. CSCs will be responsible for supervising and guiding construction contractors during project construction phase. CSCs will have a qualified Environment, Health and Safety Officer who will be responsible for supervising construction contractors to ensure proper the implementation of EMP and CEMPs; and preparing and submitting consolidated quarterly EMRs to the PMO based on the CEMPs implementation.

14. ADB will conduct due diligence of environment issues during project review missions. ADB will also review the semiannual EMRs submitted by the PMO and will disclose the reports on its website. If the PMO fails to meet safeguards requirements described in the EMP, ADB will seek corrective measures and advise the IA on items in need of follow-up actions. IA will engage loan implementation environment consultant (LIEC).

15. Roles and responsibilities for the EMP implementation are presented in **Table 1**.

Table 1: Project implementation and management organizations.

Organization	Role and Responsibility
EA	- -Coordinating and overseeing project preparation and implementation. - -Coordination of strategic issues at regional or national level. - -Providing policy guidance and facilitation during implementation. - -Facilitating interagency coordination with other involved parties at the regional level (and facilitate issues and decision making at the national level, if required).
IA	- Main responsibilities include: - Contracting and administering contractors and suppliers. - Supervising construction and monitoring quality control. - Appointing a PMO ESO. - Engaging a local EMS for environmental monitoring. - Engaging a LIC including a LIEC. - Ensuring compliance with EMP and RP. - Responding to any adverse impact beyond those foreseen in the IEE and ensuring that if there are any changes in scope, the IEE/EMP will be updated as needed. - Responding to requests from relevant agencies and ADB regarding the mitigation measures and environmental monitoring program. - Identifying and implementing O&M arrangements. - Take corrective actions if needed. - Prepare environmental monitoring reports semi-annually during construction and annually during operation.
PMO	- On behalf of the EA, the PMO will be responsible for all project organization and implementation activities, including the following: - Updating IEE/EMP if needed, including EMoP. - -Ensuring that mitigation measures are included in engineering detailed design. - -Ensuring project's compliance with loan and project agreements and safeguards requirements. - Managing the activities of the design institutes, procurement agents, and consultants in accordance with government and ADB regulations. - Coordination with concerned offices, including SPG, and with external contacts. - Taking part in capacity development and training. - Establishing and operating the project complaint center with hotline. - Overseeing the project program and activities of the IA in the implementation of the project outputs.

	- Monitoring the project's physical and financial progress and compliance with project's reporting requirements, ensuring project progress reports are prepared and submitted to ADB on time. - Preparing progress reports for submission to the IA and/or PMO. - -Coordinating the activities of and meeting the requirements of ADB's review missions.
Loan Implementation Environmental Consultant (LIEC)	The LIEC will: - Review the updated IEE and EMP. - Confirm that mitigation measures have been included in detailed engineering design. - Review bidding documents to ensure that the EMP clauses are incorporated. - Review CEMPs to ensure compliance with the EMP. - Provide technical assistance and support to the PMO and contractors on mitigation measures and EMP implementation. - Deliver the construction and operation phase capacity building programs to the staff of the IA, PMO, and contractors. - Conduct site inspections in compliance with the environmental monitoring plan. - Review reports prepared by contractors and assist the PMO in preparing semiannual environmental monitoring reports.
EMS	- A qualified independent environmental monitoring station will be recruited to implement the ambient monitoring portion of the EMoP.
Contractors	- Ensure sufficient funding and human resources for proper and timely implementation of required mitigation and monitoring measures in the EMP and CEMPs throughout the construction phase. - Responsible for GRM operation during construction phase.
Construction supervision company(ies) (CSCs)	- Ensure sufficient funding and human resources for supervising and instructing contractors for proper and timely implementation of required mitigation and monitoring measures in the EMP and CEMPs throughout the construction phase. - Appoint an EHS officer to supervise and instruct contractors and their EHS officers for EMP and CEMPs implementation related to environment, occupational health and safety on construction site. - Prepare and submit quarterly EMP and CEMP monitoring reports to the PMO.
ADB	- Responsible for the following: - Review and clear the IEE and EMP and disclose on ADB website. - Approve updated IEE/EMP if appropriate and disclose on ADB website - Provide guidance to the executing and implementing agencies. - Conducting review missions. - Monitoring status of compliance with loan and project covenants, including safeguards. - Regularly updating the project information documents for public disclosure at ADB website, including the safeguards documents.

ADB = Asian Development Bank, EMP = Environmental Management Plan, O&M = operation and maintenance, PMO = project management office.

C. Potential Impacts and Mitigation Measures

16. The potential impacts of the project during pre-construction, construction and operation have been identified and appropriate mitigation measures developed (see Chapter V of the IEE). Potential impacts and the mitigation measures are presented in **Table 2.**

D. Environment Monitoring Plan

17. An EMoP to monitor the environmental impacts of the project and assess the effectiveness of mitigation measures is presented in **Table 3.** The EMoP includes both compliance inspection undertaken by the PMO Environment Officer, and ambient air, noise, and wastewater monitoring undertaken by the 3rd party environmental monitoring entity. Ambient monitoring will be conducted in compliance with relevant PRC regulations, methods and technical specifications. An environment expert will be engaged to verify the monitoring information.

18. The data and results of environmental compliance inspection and monitoring activities will be used to assess: (i) the extent and severity of actual environmental impacts against the predicted impacts and baseline data collected before the project implementation; (ii) performance or effectiveness of environmental mitigation measures or compliance with pertinent environmental rules and regulations; (iii) trends in impacts; (iv) overall effectiveness of EMP implementation; and (v) the need for additional mitigation measures and corrective actions if non-compliance is observed.

E. Institutional Strengthening and Capacity Building

19. The institutional strengthening and capacity building focuses on the safeguard requirements of relevant PRC laws and regulations and the ADB SPS 2009. The training will focus on the ADB SPS; PRC safeguard requirements; development and implementation of EHS plans during construction and operation; implementation of the EMP, the EMoP, and the GRM; and worker and community health and safety issues and measures (**Table 4).**

Table 2: Environment Impacts and Mitigation Measures

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
A. Detailed Design Phase					
Incorporate Mitigation Measures and Monitoring in Detailed Design and Bidding and Contracting	Include mitigation measures and monitoring program in detailed design	Environmental mitigation and pollution control measures identified in the IEE, the EMP and the domestic EIAs will be incorporated into the detailed design.	PMO supported by LIEC	IA	Detailed Design Budget
	Include mitigation measures and monitoring program in bidding documents	Environmental mitigation measures identified in the IEE, EMP and the domestic EIA will be incorporated in the bidding documents for the project and will be included in contract documents for civil constructions and equipment installations. All contractors shall be required to strictly comply with the EMP.	PMO supported by LIEC	IA	Detailed Design Budget
	Environmental monitoring incorporated into design.	The environmental monitoring program will be incorporated into the design to ensure that environmental impacts are closely monitored and activities of the project construction and operating are closely supervised against the PRC environmental laws, regulations and standards, ADB SPS, and the project EMP and approved domestic EIA.	PMO supported by LIEC	IA	Detailed Design Budget
	Seismic risks incorporated	Mitigation measures to avoid seismic risks	PMO supported by LIEC	IA	Detailed Design

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
	into design	in the design.			Budget
Grievance Redress Mechanism (GRM)	Impacts on project Affected Persons	In accordance with the GRM presented in Chapter VIII, a staff member within the PMO will be assigned overall responsibility for the GRM; GRM training will be provided for PMO members and GRM access points; and the GRM access point phone numbers, fax numbers, addresses and emails will be disclosed to the public.	PMO supported by LIEC	EA, ADB	PMO Operating Budget
B. Construction Phase					
Flora and Fauna	Removal of vegetation	A greening plan will be implemented: – Site vegetation plans will be developed using appropriate native species. – Any existing vegetated areas impacted by pipeline works or construction of boiler rooms, workshops will be restored post-construction using appropriate native species.	DI (plan design), Contractors (plan implementation)	IA supported by LIEC	Contractor construction budget
Wastewater	Surface and groundwater contamination from construction wastewater, and domestic water	Good wastewater management practices as set out in EHS Guidelines on Construction and Decommissioning and EHS General Guidelines: – Existing toilets at the component site will be provided for the workers. – Construction wastewater generated during construction phase will be discharged to the municipal sewer system. All discharged	Contractors	IA supported by LIEC	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		construction wastewater will meet the appropriate PRC standard GB/T 31962-2015 prior to discharge. Discharged water will then be treated in the nearby WWTP. – All necessary measures will be undertaken to prevent construction materials and waste from entering drainage system. – Maintenance of construction equipment and vehicles will not be allowed on sites to reduce wastewater generation. – All construction machinery is repaired and washed at special repairing shops. No on-site machine repair, maintenance and washing shall be allowed so as to reduce wastewater generation; – Storage facilities for fuels, oil, and other hazardous materials are within secured areas on impermeable surfaces with 110% volume of the materials stored, and provided with bunds and cleanup kits; – The contractors' fuel suppliers are properly licensed, follow proper protocol for transferring fuel, and are in compliance with Transportation, Loading and Unloading of Dangerous or Harmful Goods (JT 3145-88).			
Erosion and Spoil	Soil erosion, spoil disposal	Good practice construction erosion controls and site maintenance as set out in EHS Guidelines on C&D and EHS General Guidelines:	Contractors	IA supported by LIEC	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		– At construction site, the potential for storm water runoff will be assessed and appropriate storm water drainage systems to minimize soil erosion will be implemented, including perimeter bunds and establishment of temporary detention and settling ponds to control topsoil runoff. – Land excavation and filling will be balanced so as minimize the requirement for fill material transportation. – During earthworks, the area of soil exposed to potential erosion at any time will be minimized through good project and construction management practices. – Temporary spoil storage sites (and storage containers at lane modification and stations construction sites) will be identified, designed, and operated to minimize impacts. Spoil sites will be restored at the conclusion of storage activities. – Spoil will be reused on-site to the maximum extent feasible as fill. Excess spoil that cannot be used on-site will be transported to an approved spoil disposal site. – Spoil and aggregate piles will be covered with landscape material and/or regularly watered. – Waste construction material such as residual concrete, asphalt, etc., will be properly handled for reuse or disposal.			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		– Construction and material handling activities will be limited or halted during periods of rains and high winds. – Pipelines will be installed and backfilled in a sequenced section-by-section approach. Open excavation areas during trenching activities will be minimized, and appropriate construction compaction techniques utilized. – Any planned paving or vegetating of areas will be done as soon as practical after the materials are removed to protect and stabilize the soil. – Once construction is complete, disturbed surfaces will be properly sloped and revegetated with native trees and grass.			
Air Pollution	Dust, vehicle emissions	The following air quality management measure and construction good practice as set out in EHS Guidelines on C&D and EHS General Guidelines will be implemented: – Water will be sprayed on active construction sites including where fugitive dust is being generated on a daily basis, and more frequently during windy days. – Transport vehicles will be limited to low speeds at construction sites. – Loads will be covered during truck transportation to avoid spillage or fugitive dust generation. Fine	Contractors	IA supported by LIEC	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		materials will be transported in fully contained trucks. – Construction site roads will be well maintained and watered and swept on an as-needed basis. Construction site road entry points will be equipped with truck drive through wash ponds. – Transport routes and delivery schedules will be planned to avoid densely populated and sensitive areas, and high traffic times. – Store petroleum or other harmful materials in appropriate places and cover to minimize fugitive dust and emission. – Provide regular maintenance to vehicles in order to limit gaseous emissions (to be done off-site). – Temporary fencing will be erected around pipeline installation activities. – Construction spoil and other construction materials will be temporary stored using containers, but they may the potential to generate dust. Thus, containers will be covered and/or watered if necessary. – Muddy or dusty materials on public roads outside the exits of works areas will be cleaned immediately. – On-site asphalting and concrete batching is prohibited.			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		– Disturbed site will be revegetated as soon as possible after the completion of pipeline installation.			
Noise	Impacts from construction noise on sensitive resources	To ensure construction activities meet PRC noise standards (Noise Standards for Construction Site Boundary, GB 12523-2011) and to protect workers, the following mitigation measures and construction good practice as set out in EHS Guidelines on C&D and EHS General Guidelines will be implemented: – Construction activities will be planned in consultation with local authorities and communities so that activities with the greatest potential to generate noise and vibration are planned during periods of the day that will result in the least disturbance. – Construction activities, and particularly noisy ones, are to be limited to reasonable hours during the day and early evening. Construction activities will be strictly prohibited during the nighttime (22:00 h to 07:00 h). Exceptions will only be allowed in special cases, and only after getting approval of the surrounding residents, local EPB and other relevant departments. And nearby residents should be notified of such night time activities well in advance. – When undertaking construction planning,	Contractors	IA supported by LIEC	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		simultaneous high-noise activities will be avoided, and high noise activities will be scheduled during the day rather than evening hours. Similarly, construction site will be planned to avoid multiple high noise activities or equipment from operating at the same location. – Low-noise equipment will be selected as much as possible. Equipment and machinery will be equipped with mufflers and will be properly maintained to minimize noise. – Noise PPE will be provided to workers to meet the requirements in occupational exposure limits for hazardous agents in work place Part 2: physical agents (GBZ 2.2-2007) and EHS Guidelines. – Transportation routes and delivery schedules will be planned during detailed design to avoid densely populated and sensitive areas and high traffic times. – Vehicles transporting construction materials or waste will slow down and not use their horn when passing through or nearby sensitive locations, such as residential communities, schools and hospitals. – Special attention will be paid to protect sensitive sites near the component site: high noise construction activities will be positioned as far away from sensitive sites as possible. – To minimize noise from cleaning of heating			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		pipelines will be minimized by utilization of low noise valves, mufflers after the valves and sound insulation on the external walls of pipelines.			
Solid Waste	Inappropriate Waste Disposal	The following solid waste management measure and construction good practice as set out in EHS Guidelines on C&D and EHS General Guidelines will be implemented: – Wastes will be reused or recycled to the extent possible. – Littering by workers will be prohibited. – Excavated soil will be backfilled onsite to the extent possible. Excess spoil that cannot be used on-site will be transported to an approved spoil disposal site. – Existing domestic waste containers will be used for domestic waste collection at work sites. Domestic waste will be collected on a regular basis by the local sanitation departments and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and requirements. – Construction waste dumpsters will be provided at all construction sites. Construction waste will be collected on a regular basis by a licensed waste collection company and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and	Contractors, local sanitation departments (domestic waste), licensed waste collection companies (construction waste)	IA supported by LIEC	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		requirements. – There should be no final waste disposal on site. Waste incineration at or near the site is strictly prohibited. – Cuttings are typically reused if they are non-toxic (e.g. as construction fill) or disposed of in a certified and engineered landfill facility. – Contractors will be held responsible for proper removal and disposal of any significant residual materials, wastes, spoil, waste from contaminated soils that remain on the site after construction.			
Hazardous and Polluting Materials	Inappropriate transportation, storage, use and spills	The following mitigation measures and construction good practice as set out in EHS Guidelines on C&D and EHS General Guidelines will be implemented: – A hazardous material handling and disposal protocol that includes spill emergency response will be prepared and implemented by contractors. – Storage facilities for fuels, oil, chemicals and other hazardous materials will be within secured areas on impermeable surfaces provided with dikes with a 110% volume, and at least 300 m from drainage structures and important water bodies. A standalone site within the storage facility will be designated for hazardous wastes. – Signs will be placed at chemicals and hazardous	Contractors, waste management companies	IA supported by LIEC	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		materials storage sites to provide information on type and name of chemicals and hazardous materials. – Suppliers of chemicals and hazardous materials must hold proper licenses and follow all relevant protocols and PRC regulations and requirements. – A licensed company will be hired to collect, transport, and dispose of hazardous materials in accordance with relevant PRC regulations and requirements.			
Socioeconomic Resources	**Community Disturbance and Safety**	– Transportation routes and delivery schedules will be planned during detailed design to avoid densely populated and sensitive areas and high traffic times. – Vehicles transporting construction materials or wastes will slow down and not use their horn when passing through or nearby sensitive locations, such as residential communities, schools and hospitals. – Signs will be placed at construction sites in clear view of the public, warning people of potential dangers such as moving. All sites will be made secure, discouraging access by members of the public through appropriate fencing with security guards whenever appropriate.	DI (plan design), Contractors (plan implementation)	IA supported by LIEC	Contractor construction budget
	Worker Occupational	Contractors will implement adequate precautions to protect the health and safety of their workers:	EHS Plan Developed by LIEC	IA supported	LIEC Budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
	Health and Safety	– Each contractor will undertake H&S risk assessment of construction works and implement relevant construction phase EHS plan in line with construction good practice as set out in EHS Guidelines on C&D and Occupational H&S guidelines.	EHS Plan implemented by contractors	by LIEC	
		– Identify and minimize the causes of potential hazards to workers. Implement appropriate safety measures.		IA supported by LIEC	Contractor construction budget
		– Provide training to workers on occupational health and safety, emergency response, especially with respect to using potentially dangerous equipment and storage, handling and disposal of hazardous waste. Induction will be conducted before construction and no worker is allowed on site without induction.			
		– Ensure that all equipment is maintained in a safe operating condition.			
		– Provide appropriate PPE to workers.			
		– Provide procedures for limiting exposure to high noise or high temperature working environments in compliance with PRC occupational exposure limits for hazardous agents in work place Part 2: physical agents (GBZ 2.2-2007).			
		– Ensure regular safety meetings with staff.			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
Physical Cultural Resources	As yet unknown PCRs may be damaged if proper precautions are not taken.	A construction phase chance find procedure will be established and activated if any chance finds of PCRs are encountered: – construction activities will be immediately suspended if any PCRs are encountered; – destroying, damaging, defacing, or concealing PCRs will be strictly prohibited in accordance with PRC regulations; – local Cultural Heritage Bureau will be promptly informed and consulted; and, – construction activities will resume only after thorough investigation and with the permission of the local Cultural Heritage Bureau. – In case of any PCR is found, ADB SPS 2009 requirements as well as PRC laws and regulations will be followed.	Contractors	IA supported by LIEC and local Cultural Heritage Bureau	In the event that a PCR is discovered, the direct cost for comp-ensation to contractor will be covered by a special fund to be devel-oped for cultural relic protection.
C. Operation Phase					
Wastewater	Discharge of Production and Domestic Wastewater	– Wastewater from soften water treatment process and regeneration processes will be discharged to the municipal sewerage system. – Boiler blow down, wastewater from regeneration process and heating system blow down will be discharged to the municipal sewerage system. – No metal (chromium or zinc) permitted to use as	IA	EA supported by LIEC, EPB	IA operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		scaling and corrosion additive. – Because wastewater generated by equipment and pump contains oil, the wastewater will be treated in oil separator and will be discharged to the municipal sewerage system. – Domestic wastewater will be produced from worker sanitation facilities. Domestic wastewater will be treated in digestion tank and will be discharged to the municipal sewerage system.			
Solid Waste	Collection and Disposal	– Domestic waste bins will be provided and domestic waste will be routinely collected by the local sanitation department for recycling, if possible, or final disposal at an approved waste disposal site. – No permanent on-site solid waste disposal will be permitted at project site. – No burning of wastes will be permitted at project site. – Ash and slag will be sold out for utilization and recycling. – Oily waste will be collected, transported and treated by a certificated hazardous waste treatment company.	IA, District Sanitation Departments	EA supported by LIEC, EPB	IA operation budget
Chemical and Hazardous Materials	Inappropriate Management	- A registry of all activities that involve the handling of potentially hazardous substances	IA, Licensed Contactors	EA supported by LIEC,	IA operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		will be developed, including protocols for the storage, handling and spill response. This will include all fuels, oils, grease, lubricants, and other chemicals.		EPB	
		- All chemicals, toxic, hazardous, and harmful materials will be transported in spill proof tanks with filling hoses and nozzles in working order,			
		- All chemicals, toxic, hazardous, and harmful materials will be stored in secure areas with impermeable surfaces and protective dikes such that spillage or leakage will be contained from affecting soil, surface water or groundwater systems. The area should be 110% volume of storage capacity. Their usage will be strictly monitored and recorded.			
		- Material safety data sheets (MSDSs) will be posted for all hazardous materials.			
		- Oil absorbents will be readily accessible in marked containers.			
		- Good housekeeping procedures will be established to avoid the risk of spills.			
		- Spills will be dealt with immediately, and personnel will be trained and tasked with this responsibility.			
		- Workers will be properly trained before handling hazardous wastes and have the			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		requisite PPE. - Hazardous waste will be temporarily stored in closed containers away from direct sunlight, wind, water and rain in secure designated areas with impermeable surfaces and protective dikes such that spillage or leakage will be contained. - Hazardous wastes including waste urea, oily waste, waste chemicals and waste ion exchange resin will be collected and disposed by licensed contractors on an as needed basis. - Engineering and administrative control measures will be implemented to avoid or minimize the release of hazardous substances into the work environment keeping the level of exposure below internationally established or recognized limits. - Keep the number of employees exposed, or likely to become exposed, to a minimum to hazardous substances. - Communicating chemical hazards to workers through labeling and marking according to national and internationally recognized requirements and standards, including the International Chemical Safety Cards (ICSC), Materials Safety Data Sheets (MSDS), or equivalent. Any means of written			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		communication should be in an easily understood language and be readily available to exposed workers and first-aid personnel. - Training workers in the use of the available information (such as MSDSs), safe work practices, and appropriate use of PPE.			
Noise	Impact on Sensitive Receptors	– Low-noise equipment will be used as far as possible, and noise reduction measures such as noise elimination, shock absorption, insulated enclosures and sound dampening materials on exterior walls will be implemented. – All equipment will be properly maintained in order to minimize noise. – Appropriate noise PPE will be provided to the workers who are likely to be exposed to high noise level environments to meet the requirements in occupational exposure limits for hazardous agents in work place Part 2: physical agents (GBZ 2.2-2007), EHS General Guidelines and EHS Guidelines on Occupational H&S. – Layout for project site will be reasonable planned to reduce noise.	IA	EA supported by LIEC, EPB	IA operation budget
Community and Occupational Health and Safety	Natural gas leakage	– All natural gas works will be in compliance with relevant PRC building code requirements, including the Code for Design of City Gas Engineering (GB 50028-2006) and Regulation on			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		Electric Apparatus Design for Explosion and Fire Risk Environment (GB50058-92). – Independent gas regulation stations will be constructed at least 14 meters away from other buildings and 30 m from the site boundary, to minimize the risk of explosion damaging other project facilities or the public.[a] – The gas regulation stations will be specially designed to withstand and contain explosions following PRC regulations. – Gas regulation stations and the connection to the boilers will be equipped with flammable gas detection, alarm and fire suppression systems. Electrical devices within the explosion risk area will be safety equipped. – Gas pipelines will be grounded and equipped with anti-lightning devices where applicable. – All other at risk areas will have flammable gas detection and alarm systems able generate audible and visual alarms, and automatic fire suppression systems. – All gas related devices will be brightly colored and equipped with warning signs. – The nearby communities will be informed of the potential risks of fire and explosion and the emergency response plan.			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
	Risks to Workers and Community	– Operation phase EHS plan and traffic management plan will be developed and implemented and workers will be trained regularly on their implementation. – PPE including goggles, gloves, and safety shoes will be provided to workers. Noise protection equipment will be provided to workers in high-noise area. Noise areas with more than 85 dB(A) shall be marked and hearing protections shall be provided to workers. – Noise level inside control room should be no more than 60 dBA. – Provide training to workers on occupational health and safety, and emergency response. – Pipelines will be grounded and equipped with anti-lightning devices where applicable. – Vehicles transporting materials or wastes will slow down and not use their horn when passing through or nearby sensitive locations, such as residential communities, schools and hospitals. – Safe traffic control measures, including road signs and flag persons to warn of dangerous conditions will be taken as needed. Regular maintenance of vehicles to minimize potential accidents caused by equipment malfunction. – Natural gas systems will be designed in strict	Plans developed by LIEC Plans implemented by IA	EA supported by LIEC and authorities	IA operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		compliance with relevant PRC fire, health and safety standards. Fire compartments will be established based on the fire risk, and fire-resistant buildings/structures will include fire-proof doors and windows. – Fire-alarm and suppression systems will be installed and tested regularly to ensure it functions properly. – Regular inspection and maintenance of pressure vessels and piping will be conducted. Adequate ventilation in work areas to reduce heat and humidity will be installed. Surfaces where workers come in close contact with hot equipment will be shielded. Warning sign will be placed in high temperature areas.			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
	Emergency Response	A draft emergency risk and response has been established in accordance with the "National Environmental Emergency Plan" (24 January 2006), the "National Environmental Emergency Plan" (24 January 2006), other relevant PRC laws, regulations and standards, as well as World Bank EHS Guidelines and ADB's SPS 2009, and will include measures in the World Bank EHS guidelines with respect to occupational and community health and safety. The plan must be established and in place before the component is operational. **Indicative plan requirements are as follows:** – Procedures for responding to different types of emergency situations will be identified in the response plan. – Emergency exercises will be conducted and they should include different emergency scenarios. **Training Requirements** – Appropriate operating and maintenance employees will be trained to ensure that they are knowledgeable of the requirements of emergency response plan. Training will be provided as follows: – Initial training to all employees before the gas-fired facilities are put in operation. – When new equipment, materials, or processes are introduced. – When emergency response procedures have been updated or revised. **Annual Emergency Simulation** – Simulated emergency exercises will be conducted	Plans developed by PMO with support from LIEC Plans implemented by IA	EA supported by LIEC and local emergency authorities	LIEC budget and IA budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	

		at least annually.
		
		Receiving Notification of a Possible Emergency
		– When a supervisor receives a report of a possible emergency situation, he/she should obtain at minimum the following information from the reporting person:
		  – Name of person reporting emergency;
		  – Nature of emergency - leak, fire, interruption of service if leak, odor present, etc.
		  – Details of emergency: location, amount, how long has the odor been noticed, what actions have been taken, etc.
		  – Leaks or other emergencies require prompt investigation.
		
		Immediate On-site Action
		– The first responder will assess the nature of the report. This assessment should include the status of the emergency, an estimation of how the incident might progress, and an evaluation of the manpower, equipment, and materials needed to adequately cope with the situation.
		– If there is a strong odor or any measurable reading of gas detected inside a structure:
		  – Clear the building of all occupants.
		  – Eliminate potential ignition sources.
		  – Localize or isolate the problem and shut off gas as needed.
		  – Determine the extent of the hazardous area and establish a restricted area.
		– The responding supervisor shall determine the extent of the emergency and inform the			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		dispatcher of the condition at the site. – If emergency procedures are put into effect, the responding supervisor should select a location and establish an emergency command post. – The responding supervisor will assign one person to remain at the command post to maintain communications until the emergency is over. – When necessary, the command post will be coordinated with the local emergency responders. When local emergency responders are involved, they will be in charge of the incident. – The responding supervisor will make himself known to fire and/or police department officials, or other authority having jurisdiction, and will remain with them during the emergency. – All employees reporting to the scene of the emergency will report to the command post for identification and instructions. – Key personnel will be alerted, and it will be their responsibility to keep the emergency personnel under their supervision informed and available for emergency call out. – When a system failure cannot be made safely by normal procedures, emergency shutdown procedures should be implemented. – Reduce system pressure or segment a section before repair procedures are implemented. – Well trained and qualified personnel will be dispatched to monitor system pressure and repair work. **Communication with Public Officials** – When an emergency resulting in a hazard to the public safety occurs, the local fire department,			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		police, the city medical emergency center and other relevant public officials should be notified. An emergency call list will be prepared and make it available at the plant control room.			
Offsets		LIEC will support the IA in monitoring the offsets and include the information in the environmental monitoring reports	IA with the support of LIEC	EA	IA operation budget

DI = design institute, EMP = environment monitoring plan, EMS = environment monitoring station, EPB = environment protection bureau, GRM = grievance redress mechanism, IA = implementing agency, LIEC = loan implementation environmental consultant.

[a] Gas regulation stations are defined as Class II explosion risks. Space within 4.5 meter away from a regulation station is included in the explosion risk region, as regulated in *Regulation on Electric Apparatus Design for Explosion and Fire Risk Environment* (GB50058-92). In the *Code for Design of City Gas* Engineering (GB 50028-2006) the recommended distance from a gas regulation station with no more than 1.6 MPa inlet pressure to other buildings is 9 m.

Source: Domestic Project EIA Report (2015) and TA consultants.

Table 3: Environmental Monitoring Plan (EMoP)

Subject	Parameter/Methodology	Monitoring Location	Frequency	Implemented by	Supervised by
A. Construction Phase					
Air Pollution	Ambient dust monitoring (TSP, PM_{10}, $PM_{2.5}$) following PRC requirements	Boundaries of the construction site	Quarterly during construction season	EMS	EA, EPB
	Compliance inspection of implementation of air pollution control measures	Construction site	Daily during construction season	IA	EA, EPB
Wastewater	Wastewater sampling - COD, TSS, pH etc. following PRC requirements	Wastewater discharge point of the construction site	Monthly during construction	IA	EA, EPB
Noise	Ambient noise monitoring (day and night Leq dB(A)) using portable monitoring device following PRC requirement	Boundaries of the construction site and sensitive receptors in 100 m	Weekly during construction season	EMS	EA, EPB
Solid Waste	Compliance inspection of implementation of solid waste management measures	Waste collection and disposal sites	Monthly during construction	IA	EA, EPB
Hazardous and Polluting Materials	Compliance inspections of implementation of hazardous materials management measures	Storage facilities for fuels, oil, chemicals and other hazardous materials. Vehicle and equipment maintenance areas.	Monthly during construction	IA	EA, EPB
Flora and Fauna	Compliance inspection of land clearing to ensure mitigation measures are being implemented	Construction site	Monthly during construction	IA	EA, EPB

Subject	Parameter/Methodology	Monitoring Location	Frequency	Implemented by	Supervised by
Socioeconomic Impacts	Compliance inspection of implementation of traffic control measures	Construction site roads. Transportation routes.	Monthly during construction season	IA	EA, EPB
	Compliance inspection of implementation of Occupational and Community Health and Safety measures including records on near miss, minor, major, fatal accidents and an Emergency Response Plan	Construction site	Monthly during construction season	IA	EA, EPB
B. Operation Phase					
Wastewater	Wastewater sampling - COD, TSS, pH etc. following PRC requirements	Discharge outlet to municipal sewer of the component site	Quarterly during none heating season and once during heating season	IA	EA, EPB
Exhaust gas	Exhaust gas sampling- SO_2, NOx and PM	Outlet of the stacks Ambient air quality monitoring	Quarterly during heating season	IA	EA, EPB
	CO_2G monitoring	Exhaust stack	Semi-annually	IA	EA, EPB
Solid Waste	Compliance inspection to of operation phase solid waste management measures implementation	Component site	Semi-annually	IA	EA, EPB
Noise	Noise monitoring (day and night Leq dB(A))	Boundaries of the component site and sensitive receptors in 100 meters	Quarterly	EMS	EA, EPB

Subject	Parameter/Methodology	Monitoring Location	Frequency	Implemented by	Supervised by
Hazardous and Polluting Materials	Compliance inspection of operation phase Hazardous Materials Management Plans (HMMPs) implementation	Component site	Semi-annually	IA	EA, EPB
Health and Safety and Emergency Response	Compliance inspection of operation phase occupational and community health and safety management measures including keeping records on near miss, minor, major, fatal accidents and an Emergency Response Plan implementation	Component site	Semi-annually	IA	EA, EPB
Environmental acceptance	Compliance testing for environment acceptance	Component site	Once	IA	EA, EPB

Table 4: Institutional strengthening and training program.

Training Topic	Trainers	Attendees	Contents	Times	Days	# Persons	Budget (USD)
Construction Phase Environment, Health and Safety Training	LIEC	Contractors, PMO, IA, EA	**ADB and PRC laws, regulations and policies** – ADB's Safeguard Policy Statement – Project applicable PRC environmental, health and safety laws, policies, standards and regulations – International environmental, health and safety management practice in civil irrigation and drainage construction **GRM** – GRM structure, responsibilities, and timeframe	3 (once prior to start of construction, and then once during second and third years)	2	30	**Training Development** Fixed costs: $2000 per course delivery x 3 = $ 6,000

			– Types of grievances and eligibility assessment **Implementation of Construction Phase EMP** – Impacts and mitigation measures – Monitoring and reporting requirements – Non-compliance and corrective actions				
Operation Phase Environment, Health and Safety Plan Training	LIEC	PMO, IA, EA	**ADB and PRC laws, regulations and policies** – ADB's Safeguard Policy Statement – Project applicable PRC environmental, health and safety laws, policies, standards and regulations – International environmental, health and safety management practice in civil irrigation and drainage operation **GRM** – GRM structure, responsibilities, and timeframe – Types of grievances and eligibility assessment **Implementation of Operation Phase EMP** – Impacts and mitigation measures – Monitoring and reporting requirements – Non-compliance and corrective actions	3 (once prior to start of operation, and then once during second and third years)	2	30	**Training Development** Fixed costs: $2000 per course delivery x 3 = $6,000
			Total	**6**		**60**	**$12,000**

F. Reporting Requirements

20. **Environmental reporting.** The CSCs will submit monthly reports to the PMO on implementation and compliance with the EMP and CEMPs, including information on all spills, accidents including near miss, minor, major, fatal accidents, grievance received, and appropriate actions taken.

21. Based on the CSCs' monthly EMP progress reports and the compliance inspection and ambient monitoring results, the PMO will prepare environmental reports semi-annually during construction and annually during operation including EMP implementation and monitoring results for submission to the IA and EA. The PMO ESO with the support from the LIEC will prepare EMRs for onward submission to the IA and the PMO, and then to ADB. The reports should assess the project's compliance with the EMP and PRC environmental standards, identify any environment-related implementation issues and necessary corrective actions, and reflect these in a corrective action plan. The performance of the contractors in respect of environmental compliance will also be reported, as will the operation and performance of the project GRM, environmental institutional strengthening and training, and compliance with all safeguards covenants.

22. **Review by ADB.** ADB will review the EMRs and ADB missions will inspect the project progress and implementation on site twice a year. For environmental issues, inspections will focus mainly on (i) monitoring data; (ii) the implementation status of project performance indicators specified in the loan covenants on the environment, environmental compliance, implementation of the EMP, and environmental institutional strengthening and training; (iii) the environmental performance of contractors, CSCs and the PMO; and (iv) operation and performance of the project GRM.

23. **Environmental acceptance reporting.** Within 3 months after completion, or no later than 1 year with permission of the Jinan EPB, an environmental acceptance report shall be prepared by a licensed institute in accordance with the PRC Regulation on Project Completion Environmental Audit (MEP, 2001), approved by the relevant environmental authority, and reported to ADB. The environmental acceptance report will indicate the timing, extent, effectiveness of completed mitigation and of maintenance, and the need for additional mitigation measures and monitoring (if any) during operation at least until the project completion report is prepared.

24. The environmental reporting requirements are summarized in the **Table 5**.

Table 5: Reporting Requirements

Report	Prepared by	Submitted to	Frequency
A. Construction Phase			
EMP implementation reports	CSC	PMO	Monthly
Compliance monitoring reports	EMS	PMO, IA	Quarterly
Environmental monitoring reports	PMO with the support of LIEC	ADB	Semi-annually
B. Operation Phase			

Report	Prepared by	Submitted to	Frequency
Environmental monitoring report	PMO with the support of LIEC	ADB	Annually

G. Performance Indicators

25. Performance indicators (**Table 6**) have been developed to assess the implementation of the EMP. These indicators will be used to evaluate the effectiveness of environmental management during the component implementation.

Table 6: Performance Indicators

No.	Description	Indicators
1	Staffing	(i) PMO established with appropriately qualified staff including Environmental Officer. (ii) Appropriately qualified environmental expert recruited if needed. (iii) 3rd party environmental monitoring entity engaged.
2	Budgeting	(i) Environment mitigation cost during construction and operation is sufficiently and timely allocated. (ii) Environment monitoring cost is sufficiently and timely allocated. (iii) Budget for capacity building is sufficiently and timely allocated.
3	Monitoring	(i) Compliance monitoring is conducted by IA as per EMoP. (ii) Construction phase and operation phase ambient and effluent monitoring is conducted by EMS.
4	Supervision	(i) IA to review the implementation of EMP. (ii) ADB review missions.
5	Reporting	(i) Semi-annual environmental monitoring reports during construction phase and annual reports operation phase prepared by the IA are submitted to EA and ADB.
6	Capacity Building	(i) Training on ADB safeguard policy, EMP implementation, and GRM is provided during component implementation.
7	Grievance Redress Mechanism	(i) GRM contact persons are designated at all IA and the PMO, and GRM contact information disclosed to the public before construction. (ii) All complains are recorded and processed within the set time framework in the GRM of this IEE.
8	Compliance with PRC standards	(i) Project complies with the PRC's environmental laws and regulations and meets all required standards.

H. Estimated Budget for EMP Implementation

26. The estimated budget for EMP implementation of the project is presented in **Table 7**. Costs are presented for mitigation implementation, ambient monitoring, capacity building, implementation support if needed, and GRM implementation. The costs do not include salaries of PMO staff.

I. Mechanisms for Feedback and Adjustment

27. The effectiveness of mitigation measures and monitoring plans will be evaluated through a feedback reporting system. If, during compliance inspections and monitoring, substantial deviation from the EMP is observed, then the PMO ESO and LIEC will consult with the PMO and Jinan EPB and propose appropriate changes to the EMP monitoring and mitigation plan.

28. Any EMP adjustments will be subject to ADB review and approval and ADB may pursue additional environmental assessment and, if necessary, further public consultation. The revised EMP with ADB confirmation is subject to reposting on the ADB's website as the ADB public communications policy requires. The revised EMP will be passed on to the contractor(s) for incorporation into the CEMPs for implementation

J. Environmental Acceptance

29. After a three months trial operation period the Jinan EPB will conduct an environmental acceptance inspection for the component and issue environmental acceptance approvals. If the component is in compliance with all conditions for approval of the domestic EIA, the component can be put into formal operation.

Table 7: Estimated Budget for Implementing EMP

Construction Phase						**Source of Funds**
1. Ambient Monitoring	**Unit**	**Unit Cost**	**# Times**	**Cost USD**	**Cost RMB**	
Air - TSP	Quarterly	$ 300	12	$ 3,600	¥22,873	Counterpart Financing
Noise	Quarterly	$ 200	12	$ 2,400	¥15,249	
Subtotal				***$ 6,000***	***¥38,122***	
2. Capacity Building	**Unit**	**Course Cost**	**# Times**	**Cost USD**	**Cost RMB**	
Construction Phase HSE Plan Development and Training	EHS Plan Development	$ 2,000	3	$ 6,000	¥38,122	Counterpart Financing
	EHS Course Development	$ 2,000	1	$ 2,000	¥12,707	
	EHS Course Delivery	$ 4,000	1	$ 4,000	¥25,415	
Subtotal				***$ 12,000***	***¥76,244***	
TOTAL Construction Phase				***Cost USD***	***Cost RMB***	
				$ 18,000	***¥114,367***	

Operation Phase (first 2 years)						
	Unit	**Unit Cost**	**# Times**	**Cost USD**	**Cost RMB**	Counterpart
1. Ambient Monitoring	**Unit**	**Unit Cost**	**# Times**	**Cost USD**	**Cost RMB**	
Exhaust gas	Seasonal Sampling	$ 300	14	$ 4,200	¥26,686	
Noise	Seasonal Sampling	$ 200	29	$ 5,800	¥36,851	Counterpart Financing
Wastewater	Seasonal Sampling	$ 150	5	$ 750	¥4,765	
Subtotal				***$ 6,550***	***¥41,617***	
2. Capacity Building	**Unit**	**Course Cost**	**# Times**	**Cost USD**	**Cost RMB**	
Operation Phase HSE Plan Development and Training	EHS Plan Development	$ 2,000	3	$ 6,000	¥38,122	Counterpart Financing
	EHS Course Development	$ 2,000	1	$ 2,000	¥12,707	
	EHS Course Delivery	$ 4,000	1	$ 4,000	¥25,415	
Subtotal				***$ 12,000***	***¥76,244***	
TOTAL Operation Phase				***Cost USD***	***Cost RMB***	
				$ 18,550	***¥117,861***	
GRAND TOTAL Construction + Operation				***Cost USD***	***Cost RMB***	
				$ 36,550	***¥232,228***	

LIEC	**Unit**	**Monthly Cost**	**# Months**	**Cost USD**	**Cost RMB**	
Loan Implementation EHS Consultant	Person Months	$ 6,000	9	***$ 54,000***	***¥343,100***	ADB Loan

APPENDIX II: ASSOCIATED FACILITY DUE DILIGENCE ENVIRONMENTAL REVIEW –XINYUAN POWER PLANT

A. Introduction

1. This is an environmental due diligence report of the Xinyuan Power Plant, being conducted as part of the IEE report for West Jinan Waste Heat Utilization and Clean Energy Component, a component of the proposed Shandong Clean Heating and Cooling Project in Shandong Province of the PRC.

2. This component will utilize waste heat from Xinyuan Power Plant for district heating. The Xinyuan Power Plant is therefore an associated facility for the component, and as per the ADB Safeguard Policy Statement (SPS), an environmental audit is required.

B. Environmental Due Diligence Review Approach

3. Audits are typically used to determine the existence of any areas where the facility has risks associated with Environmental, Health and Safety (EHS) performance. The intent is to identify any deficiencies, and to propose measures for improvement that may be necessary to minimize environmental and safety risks for the proposed ADB investment. The audit provides a baseline in terms of the company's current performance based on the management systems and controls that are in place.

4. This report is based on a site visit, consultations with Xinyuan Power Plant managers and technical staff, and a review of plant environmental and technical documentation. The site visit was undertaken April 13th 2018, and included the following participants:

Environmental Audit Reviewers:
Dai Lei, PPTA National Environmental Specialist
Yun Zhou, ADB Environment Specialist

Jinan Thermal Power Co., Ltd:
Mr. Zhou Qiang, Deputy Manager
Mr. Dong Linqiang, Director of Financial Department
Ms. Zhang Linlin, Financial staff

Xinyuan Power Plant:
Mr. Sun Qiang, Deputy Manager
Mr. Li Dong, Director of Production Department

5. The audit activities included site observations, interviews with site personnel, and review of applicable documents. Time was also devoted to reviewing the environmental monitoring activities for air emissions, water discharges, and noise. The team walked through the following facilities::

(i) 6x 2,060 t/h coal fired once-through boilers;

(ii) 6x 600 MW coal fired ultra-super critical power generation units;

(iii) Cooling towers;

(iv) Central control room;

(v) Chemical water treatment workshop; and

(vi) Closed coal storage rooms.

C. Project Description

1. Type

6. The Xinyuan Power Plant is an existing coal-fired power plant for power generation. Xinyuan Power Plant was founded in 2010 with 3x 2,060 t/h coal fired once-through boilers and 3x 600 MW coal fired ultra-super critical power generation units. It belongs to Xinfa Group. The main business of Xinyuan Power Plant includes thermal power generation and heat supply. Power generation is Xinyuan Power Plant's most important and core business and the power will be supplied to Xinyuan Aluminum Industry Co. Ltd which is just next to Xinyuan TPP.

7. In 2017, Xinyuan Power Plant provided 19.2 billion kWh electricity to Xinyuan Aluminum Industry Co. Ltd.

2. Location

8. The Xinyuan Power Plant is located on a 1.35 km^2 site in Xinfa Industrial Park, Chiping County, Liaocheng (**Figure 1**). The site area is next to Xinyuan Aluminum Industry Co. Ltd (**Figure 2**). The Xinyuan Power Plant is surrounded by different industrial plants.

Figure 1: Xinyuan Power Plant's location, Chiping County, Licheng

Source: Google Earth, 2018.

Figure 2: Xinyuan Power Plant and surrounding area

Source: Google Earth, 2018.

9. **Figure 3** shows an aerial view of the plant including the boilers, cooling tower, stack and coal storage place and railway for coal transportation and unloading.

Figure 3: Xinyuan Power Plant layout

Source: Google Earth 2018

3. Purpose and Capacity

10. The plant was originally built in 2010 for power generation to Xinyuan Aluminum Industry Co. Ltd. Xinyuan Power Plant's another important business is provide district heating to Jinan by 2020. The current configuration of the plant is:

i) 6x 2,060 t/h coal fired once-through boilers;

ii) 6x 600 MW coal fired ultra-super critical power generation units;

iii) Chemical water treatment workshop;

iv) Limestone and gypsum FGD equipment;

v) Selective Catalytic Reduction (SCR) equipment; and

vi) Electrostatic precipitator and bag filter.

11. All boilers are equipped with low-NOx burner, selective catalytic reduction (SCR) denitration, limestone and gypsum FGD equipment, bag filters and electrostatic precipitators. Flue

gases are exhausted through one 240 m high stack and inner diameter at the outlet of the stack is 20m.

4. Fuel

12. Low sulphur (0.5-0.9%) coal is primarily sourced from Shanxi Province and transported by train. Annual coal consumption of the Xinyuan Power Plant in 2017 is approximately 5.82 million tons. The coal was stored in two closed coal storage rooms.

13. The two coal storage rooms are 560x100m and 420x100m. The coal storage capacity of the two rooms was around 80,000 tons. (**Figure 4**).

Figure 4: Coal storage room, Xinyuan Power Plant

Source: Environment Specialist

5. Water Supply and Wastewater

14. The Xinyuan Power Plant sources domestic water and production water from municipal water.

15. Daily domestic water consumption of Xinyuan Power Plant is around 80 m^3 per day and production water consumption is around 7,200 m^3 per day. Water for boilers is treated by filter, ultra-filtration and reverse osmosis (RO) and then used as boiler make-up water and circulation water. Concentrated water from chemical water treatment workshop is reused as desulfurization water, dust removal water and spray water of coal system. Water used in circulation cooling system is municipal water.

16. Domestic wastewater system, production wastewater system and storm water system are

separated from each other. Domestic wastewater is collected and discharged to municipal sewer. Storm water is collected by storm water system and discharged. Production wastewater is collected and discharged to municipal sewer.

17. Wastewater generated under in-normal operation like commissioning will be discharged into 2 x 2,000 m^3 emergency tanks. When operation returns to normal, water in this tank will be discharged to municipal sewer.

18. To protect groundwater and meet the anti-seepage standard, different anti-seepage are undertaken according to different places and relevant anti-seepage requirements in the fuel/chemical storage areas.

Figure 5: Xinyuan Power Plant 2x 660 MW units and one stack

Source: Environment Specialist.

6. Solid Wastes

19. In 2017, the Xinyuan Power Plant produced approximately 1,500,000 tons of fly ash, 36,000 tons of coal slag and 650,000 of desulfurization gypsum. All the desulfurization gypsum, fly ash and coal slag were sold out for recycling. Domestic waste is collected, transported and treated by local sanitation department.

20. Hazardous wastes are temporarily stored on site with proper measures, and then sent to a certificated company for treatment and final disposal by certificated trucks. The certificated company is Liaocheng Guohuan Hazardous Waste Treatment Company. The contract was presented to the audit team.

7. Noise

21. Noise sources during operation are mainly from turbines, boiler rooms, coal transportation system, fans and desulfurization equipment, and also include transformers, pumps, and cooling equipment. To reduce noise level, the Xinyuan Power Plant used low-noise equipment as far as possible and also utilized noise elimination, shock absorption, insulated enclosures and sound dampening materials to mitigate noise impacts. These measures can typically reduce noise intensity. Also, appropriate personal noise protective equipment (PPE) is provided to the workers who are likely to be exposed to high noise level environment. Noise level met the standards.

8. Chemicals

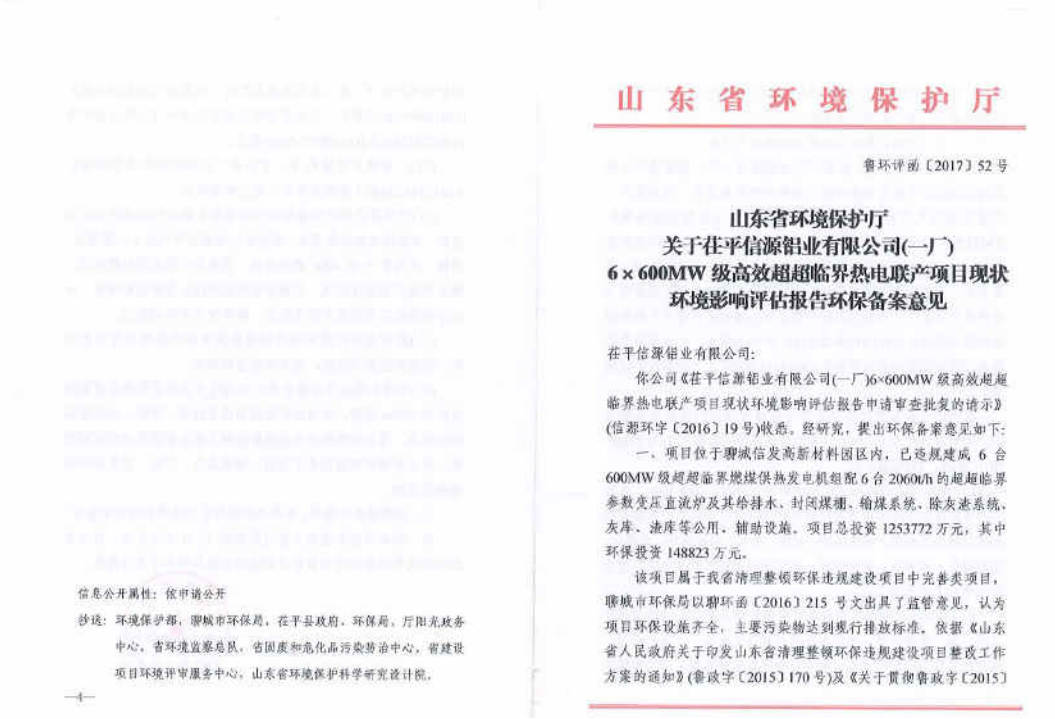
22. During the audit, the team reviewed the systems used by Xinyuan Power Plant for chemicals management which emphasizes the need for obtaining and retaining a Material Safety Data Sheet (MSDS) for each chemical stored and/or used on site, and providing employee access to this information. Xinyuan Power Plant has now installed a computerized system for keeping the MSDS records. For hazardous materials and hazardous wastes, Xinyuan Power Plant keeps copies of permits and licenses for all handlers that deliver or remove such materials.

D. Compliance for Standards, Approvals, and Permits Requirements

1. EIA and environmental acceptance

23. Before 2016, the Xinyuan Power Plant did not comply with PRC EIA requirements. In 2016, Xinyuan Power Plant prepared an EIA report and submitted the report to Shandong Provincial EPB for approval. The EIA was approved by Shandong Provincial EPB in January 4, 2017.

Figure 6: EIA approvals



山东省环境保护厅

鲁环评函〔2017〕52号

山东省环境保护厅
关于茌平信源铝业有限公司(一厂)
6×600MW级高效超超临界热电联产项目现状
环境影响评估报告环保备案意见

茌平信源铝业有限公司:

你公司《茌平信源铝业有限公司(一厂)6×600MW级高效超超临界热电联产项目现状环境影响评估报告申请审查批复的请示》(信源环字〔2016〕19号)收悉。经研究,提出环保备案意见如下:

一、项目位于聊城信发高新材料园区内,已违规建成6台600MW级超超临界燃煤供热发电机组配6台2060t/h的超超临界参数变压直流炉及其给排水、封闭煤棚、输煤系统、除灰渣系统、灰库、渣库等公用、辅助设施。项目总投资1253772万元,其中环保投资148823万元。

该项目属于我省清理整顿环保违规建设项目中完善类项目,聊城市环保局以聊环函〔2016〕215号文出具了监管意见,认为项目环保设施齐全,主要污染物达到现行排放标准。依据《山东省人民政府关于印发山东省清理整顿环保违规建设项目整改工作方案的通知》(鲁政字〔2015〕170号)及《关于贯彻鲁政字〔2015〕

信息公开属性:依申请公开

抄送:环境保护部,聊城市环保局,茌平县政府,环保局,厅阳光政务中心,省环境监察总队,省固废和危化品污染防治中心,省建设项目环境评审服务中心,山东省环境保护科学研究设计院。

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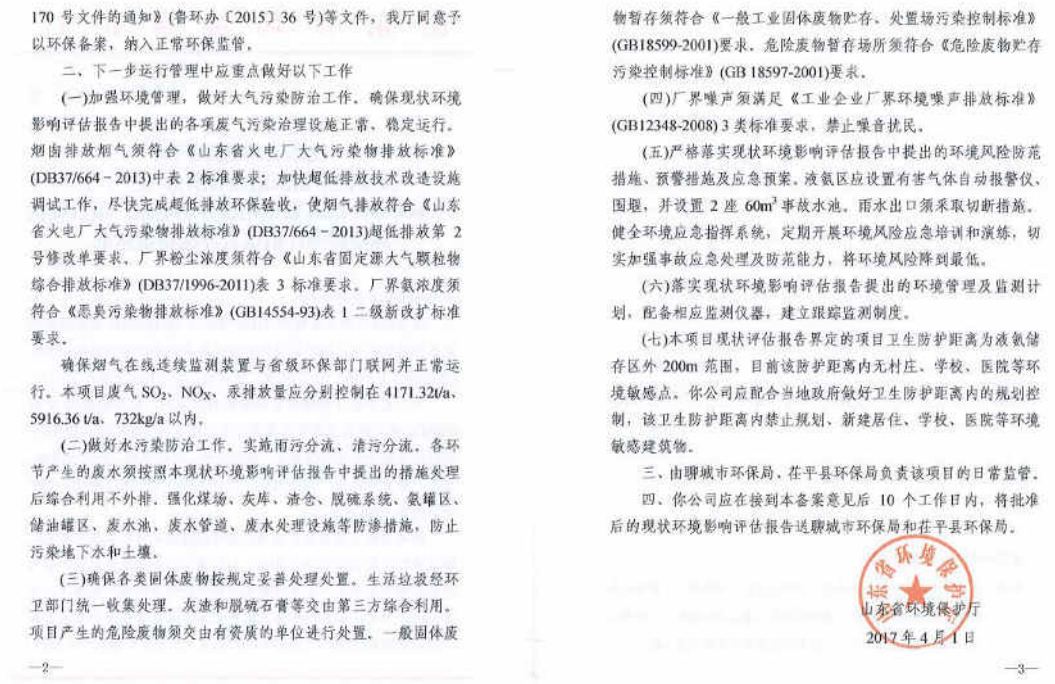

170号文件的通知》(鲁环办〔2015〕36号)等文件,我厅同意予以环保备案,纳入正常环保监管。

二、下一步运行管理中应重点做好以下工作

(一)加强环境管理,做好大气污染防治工作。确保现状环境影响评估报告中提出的各项废气污染治理设施正常、稳定运行。烟囱排放烟气须符合《山东省火电厂大气污染物排放标准》(DB37/664-2013)中表2标准要求;加快超低排放技术改造设施调试工作,尽快完成超低排放环保验收,使烟气排放符合《山东省火电厂大气污染物排放标准》(DB37/664-2013)超低排放第2号修改单要求。厂界粉尘浓度须符合《山东省固定源大气颗粒物综合排放标准》(DB37/1996-2011)表3标准要求。厂界氨浓度须符合《恶臭污染物排放标准》(GB14554-93)表1二级新改扩标准要求。

确保烟气在线连续监测装置与省级环保部门联网并正常运行。本项目废气SO_2、NO_X、汞排放量应分别控制在4171.32t/a、5916.36 t/a、732kg/a以内。

(二)做好水污染防治工作。实施雨污分流、清污分流。各环节产生的废水须按照本现状环境影响评估报告中提出的措施处理后综合利用不外排。强化煤场、灰库、渣仓、脱硫系统、氨罐区、储油罐区、废水池、废水管道、废水处理设施等防渗措施,防止污染地下水和土壤。

(三)确保各类固体废物按规定妥善处理处置。生活垃圾经环卫部门统一收集处理。灰渣和脱硫石膏等交由第三方综合利用。项目产生的危险废物须交由有资质的单位进行处置。一般固体废物暂存须符合《一般工业固体废物贮存、处置场污染控制标准》(GB18599-2001)要求。危险废物暂存场所须符合《危险废物贮存污染控制标准》(GB 18597-2001)要求。

(四)厂界噪声须满足《工业企业厂界环境噪声排放标准》(GB12348-2008)3类标准要求,禁止噪音扰民。

(五)严格落实现状环境影响评估报告中提出的环境风险防范措施、预警措施及应急预案。液氨区应设置有害气体自动报警仪、围堤,并设置2座60m³事故水池。雨水出口须采取切断措施。健全环境应急指挥系统,定期开展环境风险应急培训和演练,切实加强事故应急处理及防范能力,将环境风险降到最低。

(六)落实现状环境影响评估报告提出的环境管理及监测计划,配备相应监测仪器,建立跟踪监测制度。

(七)本项目现状评估报告界定的项目卫生防护距离为液氨储存区外200m范围,目前该防护距离内无村庄、学校、医院等环境敏感点。你公司应配合当地政府做好卫生防护距离内的规划控制,该卫生防护距离内禁止规划、新建居住、学校、医院等环境敏感建筑物。

三、由聊城市环保局、茌平县环保局负责该项目的日常监管。

四、你公司应在接到本备案意见后10个工作日内,将批准后的现状环境影响评估报告送聊城市环保局和茌平县环保局。

山东省环境保护厅
2017年4月1日

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Source: Environment Specialist.

2. Relevant Environmental Standards

24. **Table 1** presents a summary of relevant emission standards for the Xinyuan Power Plant which is more stringent than WHO Guidelines. **Table 2** presents the relevant ambient air quality standards for the Xinyuan Power Plant surrounding area. **Table 3** presents ambient noise standards. **Table 4** presents groundwater standards. Because the Xinyuan Power Plant will not discharge any wastewater to surface water body. No surface water standard is applicable.

Table 1: Summary of Environmental Pollution Standards Applicable to the Xinyuan Power Plant

Pollutant	Limit	Standards Source
Stack Emissions		
SO_2	35 mg/m^3	Ultra-low emissions standard from *Energy conservation and emission reduction upgrade and transformation Plan for coal fired power station* (2014-2020)
NOx	50 mg/m^3	
PM	10 mg/m^3	
Other		
Fugitive PM	1.0 mg/m^3 at site boundary	Table 2 of *Integrated Emission Standard of Air Pollutants* (GB 16297-1996)
Daytime Noise (06:00-22:00 h)	65dB(A) at site boundary	Class III of *Emission Standard for Industrial Enterprises at Site Boundary* (GB 12348-2008)
Nighttime noise (22:00-06:00 h)	55dB(A) (at site boundary)	

Table 2: Applicable ambient air quality standards – Class II, Ambient Air Quality Standards (GB 3095—2012) (unit: mg/m^3)

Pollutants	Annual mean (class 2)	24-hr mean (class 2)	1-hr mean (class 2)
TSP	0.200	0.300	--
PM_{10}	0.070	0.150	--
$PM_{2.5}$	0.035	0.075	--
SO_2	0.060	0.150	0.500
NO_2	0.040	0.080	0.200

Table 3: Applicable ambient environment noise standard – Class III, Environmental Quality Standards for Noise (GB3096-2008)

Item	Class II	Class III
Daytime Noise (06:00-22:00 h)	60 dB(A)	65 dB(A)
Nighttime noise (22:00-06:00 h)	50 dB(A)	55 dB(A)

Table 4: Applicable groundwater standard (Class III, *GB/T14848-2017 Quality Standard for Ground Water*)

No	Item	Unit	Limit
1	pH	-	6.5-8.5
2	Total hardness ($CaCO_3$)	mg/L	≤450
3	Fluoride	mg/L	≤1.0
4	Chloride	mg/L	≤250
5	Ammonia nitrogen	mg/L	≤0.2

6	Nitrate	mg/L	≤20
7	Nitrite	mg/L	≤0.02
8	Volatile Phenols	mg/L	≤0.002
9	Total dissolved solids	mg/L	≤1000
10	Permanganate index	mg/L	≤3.0
11	Total coliforms	/L	≤3.0

3. Environmental Monitoring

25. The Xinyuan Power Plant is equipped with a continuous emissions monitoring systems (CEMS) that monitors in real time SO_2, NOx, PM and air flow. Data is sent electronically to the Shandong EPB Data Center. Shandong EPB monitors the CEMS data, and staff indicates that Jinan EPB can be on site within as little as 1 hour if the CEMS indicates serious noncompliance. **Figure 7** shows that real-time monitoring data vs national and natural gas boiler emission standards. The emissions met the ultra-low emission standards.

Figure 7: Xinyuan Power Plant real-time CEMS data

Source: picture taken during site visit. Environment Specialist.

#3 Boiler Environmental Protection Indicators Display Board

	Xinfa Group Indicator	National Standards	Standards for Natural Gas boilers
SO_2 concentration	0.009 mg/Nm^3	200 mg/Nm^3	35 mg/Nm^3
PM concentration	0.590 mg/Nm^3	30 mg/Nm^3	10 mg/Nm^3
NOx concentration	20.33 mg/Nm^3	100 mg/Nm^3	50 mg/Nm^3

26. Manual stack emissions monitoring is also undertaken on a quarterly basis by Jinan EPB for calibration. 3rd party company is also hired by the Xinyuan Power Plant on a quarterly basis for calibration. Internal monitoring of stack emission operational parameters is also implemented which are used to manage operation.

27. Noise monitoring is undertaken at the site boundary on a quarterly basis.

4. Emission Controls and Compliance

28. All boilers are equipped with low-NOx burner, SCR denitrification, limestone and gypsum FGD equipment, bag filters and electrostatic precipitators. The plant is reported as being in full compliance with the current *Emission Standard of Air Pollutants for Thermal Power Plants* (GB 13223—2011) and ultra-low emissions standard from *Energy conservation and emission reduction upgrade and transformation Plan for coal fired power station (2014-2020)*. The real time CEMS data in **Figure 7** shows that Xinyuan Power Plant can meet the requirements. Liaocheng EPB was consulted by the consultant to identify during the site visit, no grievance or exceedance of standards occurred in the last two years.

29. Fugitive emission control measures are listed below:

i) Coal storage site is closed and installed with spray equipment which sprays water periodically;

ii) Fly ash and coal slag are mixed with water then transported for onsite treatment;

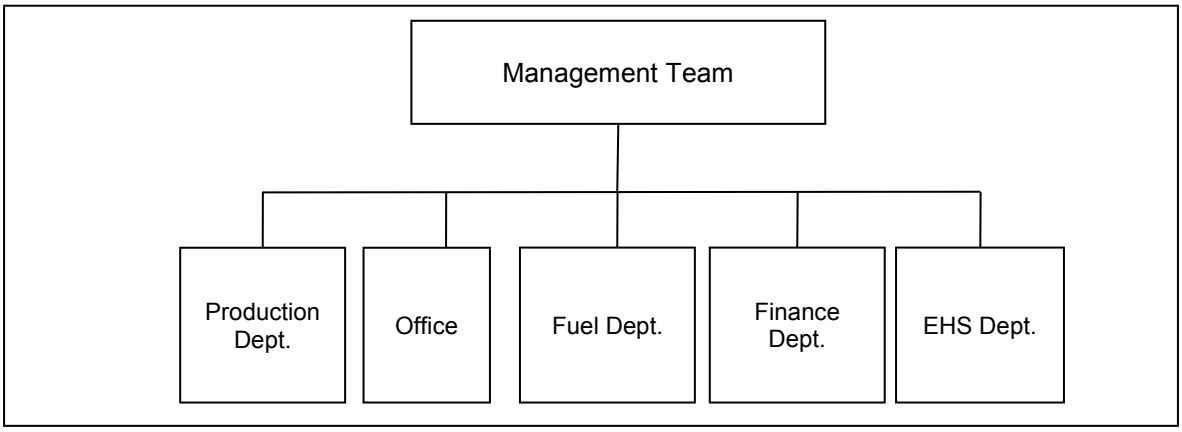
iii) Fly ash, gypsum and coal slag are stored at storage site. This site is installed with spray equipment which sprays water periodically. In strong wind weather, water spray frequency will be increased.

E. Environmental Management

1. ISO Certification, Staffing and Environmental Management

30. The Xinyuan Power Plant has a total of 514 staff. Environmental, health and safety (EHS) responsibilities are assigned to the EHS Department, which has a staff of 62 and 18 staff is responsible for environment, 14 staff is for health and 30 is for safety. (**Figure 8**).

Figure 8: Organization structure of Xinyuan Power Plant



31. This structural arrangement aims to ensure EHS issues are well incorporated in other aspects like technical, finance, and others. All EHS staff have regular meeting with the head of EHS department for close coordination and effective implementation of EHS management systems. The site has an EHS Committee that meets regularly to discuss progress and set targets and objectives going forward.

2. Staff training and PPE provision

32. Xinyuan Power Plant organizes various types of safety education and trainings for employees. Also, external construction personnel receive EHS trainings from Xinyuan Power Plant.

33. In 2017, Xinyuan Power Plant provided EHS training to 1,436 person- time. Xinyuan Power Plant provides employees with Personal Protective Equipment (PPE) that is essential for performing work activities safely. During the audit visit, at the entrance of the site, a full range of PPE was provided to the audit team. The workers on-site were all wearing proper PPEs. Thus, the audit can confirm that PPE provision and implementation is strictly followed as designed.

34. Xinyuan Power Plant maintains a comprehensive Emergency Response capability that includes an onsite Fire Department trained for a full range of emergencies that may occur at the plant. Xinyuan Power Plant also has a detailed Emergency Response Plan (ERP). The ERP is tested regularly with drills, simulations, and exercises. The staff reported that there was no accidents occurred in the last two years.

35. For some tank areas, such urea tank and hydrochloric acid tank, Xinyuan Power Plant has configured spare (reserved) tanks, cofferdams and emergency accident collecting pools to timely perform relative treatments in case of leakage occurrence, which meet the World Bank EHS guidelines requirements.

F. Conclusion

36. The audit confirmed that the EHS management systems were comprehensive and there was clear evidence of continual improvement. The audit confirmed that senior management and employees have sincere commitment to EHS.

37. Based on this environmental audit and due diligence, it can be concluded:

(i) the Xinyuan Power Plant has undergone an appropriate EIA process by Shandong EPB and has received the necessary EIA approvals and environmental acceptance approvals;

(ii) EHS polices and systems are in place and the respective EHS management programs were effective;

(iii) Comprehensive environmental monitoring programs were in place;

(iv) Combustion products are recycled into construction materials, and wastewater is recycled on site;

(v) Hazardous waste is stored according to *Standard for pollution control on hazardous waste storage* (GB18599- 2001, revised in 2013), then transported and treated by certified company;

(vi) No corrective action plan is needed.

APPENDIX III: ASSOCIATED FACILITY DUE DILIGENCE ENVIRONMENTAL REVIEW –HAOJI POWER PLANT

A. Introduction

1. This is an environmental due diligence report of the Haoji Power Plant, being conducted as part of the IEE report for West Jinan Waste Heat Utilization and Clean Energy Component, a component of the proposed Shandong Clean Heating and Cooling Project in Shandong Province of the PRC.

2. This component will utilize waste heat from Haoji Power Plant for district heating. The Haoji Power Plant is therefore an associated facility for the component, and as per the ADB Safeguard Policy Statement (SPS), an environmental audit is required.

B. Environmental Due Diligence Review Approach

3. Audits are typically used to determine the existence of any areas where the facility has risks associated with Environmental, Health and Safety (EHS) performance. The intent is to identify any deficiencies, and to propose measures for improvement that may be necessary to minimize environmental and safety risks for the proposed ADB investment. The audit provides a baseline in terms of the company's current performance based on the management systems and controls that are in place.

4. This report is based on a site visit, consultations with Haoji Power Plant managers and technical staff, and a review of plant environmental and technical documentation. The site visit was undertaken June 13th 2018, and included the following participants:

Environmental Audit Reviewers:
Dai Lei, PPTA National Environmental Specialist

Jinan Thermal Power Co., Ltd:
Mr. Dong Linqiang, Director of Financial Department
Ms. Zhang Linlin, Financial staff

Haoji Power Plant:
Mr. Liu Shun, Deputy Manager
Mr. Song Wei, Director of Production Department

5. The audit activities included site observations, interviews with site personnel, and review of applicable documents. Time was also devoted to reviewing the environmental monitoring activities for air emissions, water discharges, and noise. The team walked through the following facilities:

(i) 4x 1,150 t/h coal fired pulverized coal (PC) boilers;

(ii) 4x 360 MW coal fired super critical power generation units;

(iii) Cooling towers;

(iv) Central control room;

(v) Chemical water treatment workshop; and

(vi) Coal storage rooms.

C. Project Description

1. Type

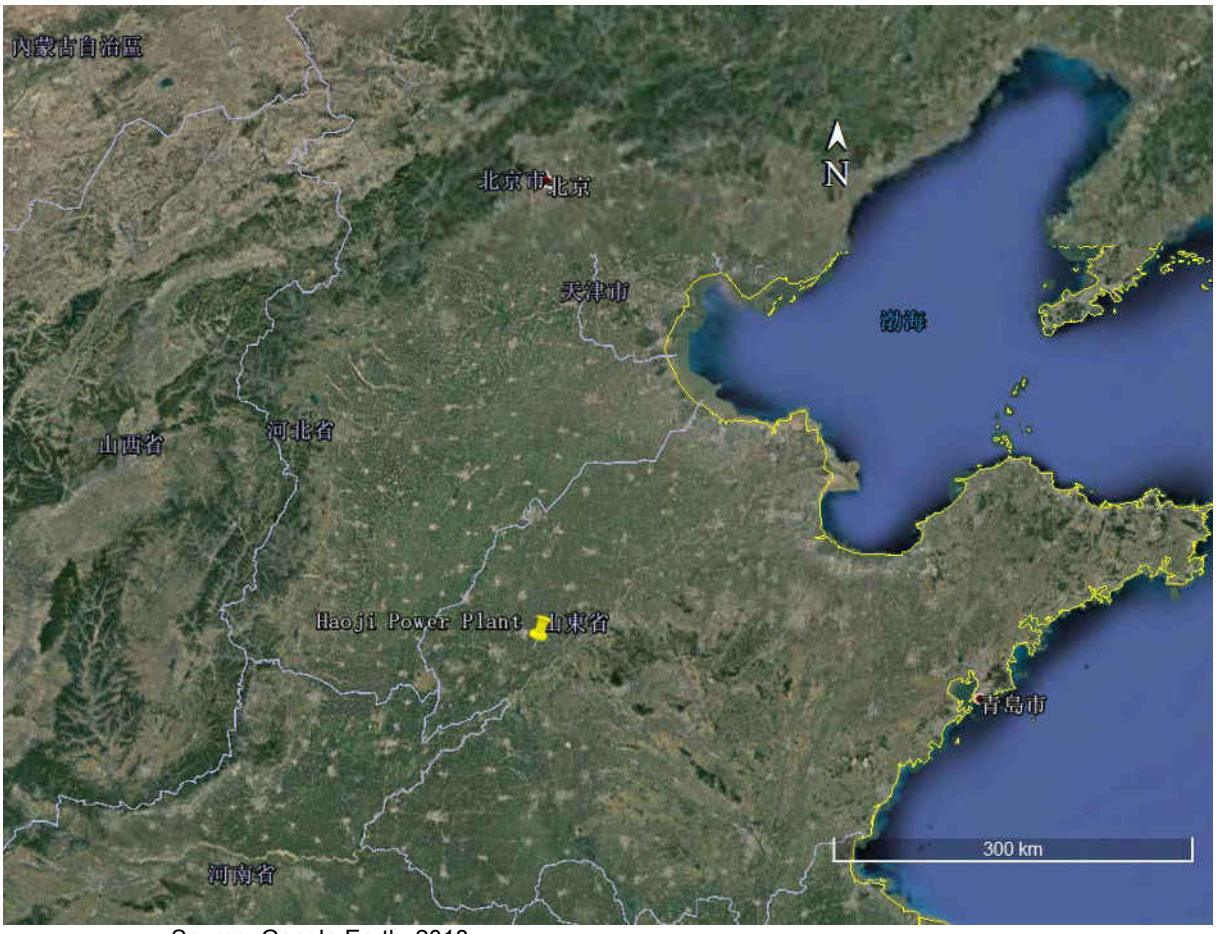
6. The Haoji Power Plant is an existing coal-fired power plant for power generation. Haoji Power Plant was founded in 2010 with 2x 1,150 t/h coal fired PC boilers and 2x 360 MW coal fired super-critical power generation units. It belongs to Xinfa Group. The main business of Haoji Power Plant includes thermal power generation and heat supply. Power generation is Haoji Power Plant's most important and core business and the power is supplied to Xinyuan Aluminum Industry Co. Ltd which is about 15 km away in northwest direction.

7. In 2017, Haoji Power Plant provided 8.1 billion kWh electricity to Xinyuan Aluminum Industry Co. Ltd.

2. Location

8. The Haoji Power Plant is located on a 1.55 km^2 site in Haoji Industrial Park, Lepingpu Town, Chiping County, Liaocheng (**Figure 1**). The Haoji Power Plant is surrounded by different industrial plants (**Figure 2**).

Figure 1: Haoji Power Plant's location, Chiping County, Licheng



Source: Google Earth, 2018.

Figure 2: Haoji Power Plant and surrounding areas

Source: Google Earth, 2018.

9. **Figure 3** shows an aerial view of the plant including the boilers, cooling tower, stack and coal storage places.

Figure 3: Haoji Power Plant layout

Source: Google Earth 2018

3. Purpose and Capacity

10. The plant was originally built in 2010 for power generation to Xinyuan Aluminum Industry Co. Ltd. Haoji Power Plant's another important business is provide district heating to Jinan by 2020. The current configuration of the plant is:

i) 4x 1,150 t/h coal fired PC boilers;

ii) 4x 360 MW coal fired super critical power generation units;

iii) Chemical water treatment workshop;

iv) Limestone and gypsum FGD equipment;

v) Selective Catalytic Reduction (SCR) equipment; and

vi) Electrostatic precipitator and bag filter.

11. All boilers are equipped with low-NOx burner, selective catalytic reduction (SCR) denitration, limestone and gypsum FGD equipment, bag filters and electrostatic precipitators. Flue gases are exhausted through one 150 m high stack and inner diameter at the outlet of the stack is 15m.

4. Fuel

12. Low sulphur (0.5-0.9%) coal is primarily sourced from Shanxi Province and transported by train. Annual coal consumption of the Haoji Power Plant in 2017 is approximately 2.52 million tons. The coal was stored in two coal storage places.

13. The two coal storage places are 120x150m and 150x120m. The coal storage capacity of the two areas was around 40,000 tons. (**Figure 4**).

Figure 4: Coal storage area, Haoji Power Plant

Source: Environment Specialist

5. Water Supply and Wastewater

14. The Haoji Power Plant sources domestic water and production water from municipal water.

15. Daily domestic water consumption of Haoji Power Plant is around 36 m^3 per day and production water consumption is around 3,000 m^3 per day. Water for boilers is treated by filter, ultra-filtration and reverse osmosis (RO) and then used as boiler make-up water and circulation water. Concentrated water from chemical water treatment workshop is reused as desulfurization water, dust removal water and spray water of coal system. Water used in circulation cooling system is municipal water.

16. Domestic wastewater system, production wastewater system and storm water system are separated from each other. Domestic wastewater is collected and discharged to municipal sewer. Storm water is collected by storm water system and discharged. Production wastewater is collected and discharged to municipal sewer.

17. Wastewater generated under in-normal operation like commissioning will discharged into 2 x 1,000 m^3 emergency tanks. When operation returns to normal, water in this tank will be discharged to municipal sewer.

18. To protect groundwater and meet the anti-seepage standard, different anti-seepage are undertaken according to different places and relevant anti-seepage requirements.

Figure 5: Haoji Power Plant cooling tower

Source: Environment Specialist.

6. Solid Wastes

19. In 2017, the Haoji Power Plant produced approximately 580,000 tons of fly ash, 15,000 tons of coal slag and 250,000 of desulfurization gypsum. All the desulfurization gypsum, fly ash and coal slag were sold out for recycling. Domestic waste is collected, transported and treated by local sanitation department.

20. Hazardous wastes are temporarily stored on site with proper measures, and then sent to a certificated company for treatment and final disposal by certificated trucks. The certificated company is Liaocheng Guohuan Hazardous Waste Treatment Company. The contract was presented to the audit team.

7. Noise

21. Noise sources during operation are mainly from turbines, boiler rooms, coal transportation system, fans and desulfurization equipment, and also include transformers, pumps, and cooling equipment. To reduce noise level, the Haoji Power Plant used low-noise equipment as far as possible and also utilized noise elimination, shock absorption, insulated enclosures and sound dampening materials to mitigate noise impacts. These measures can typically reduce noise intensity. Also, appropriate personal noise protective equipment (PPE) is provided to the workers who are likely to be exposed to high noise level environment.

8. Chemicals

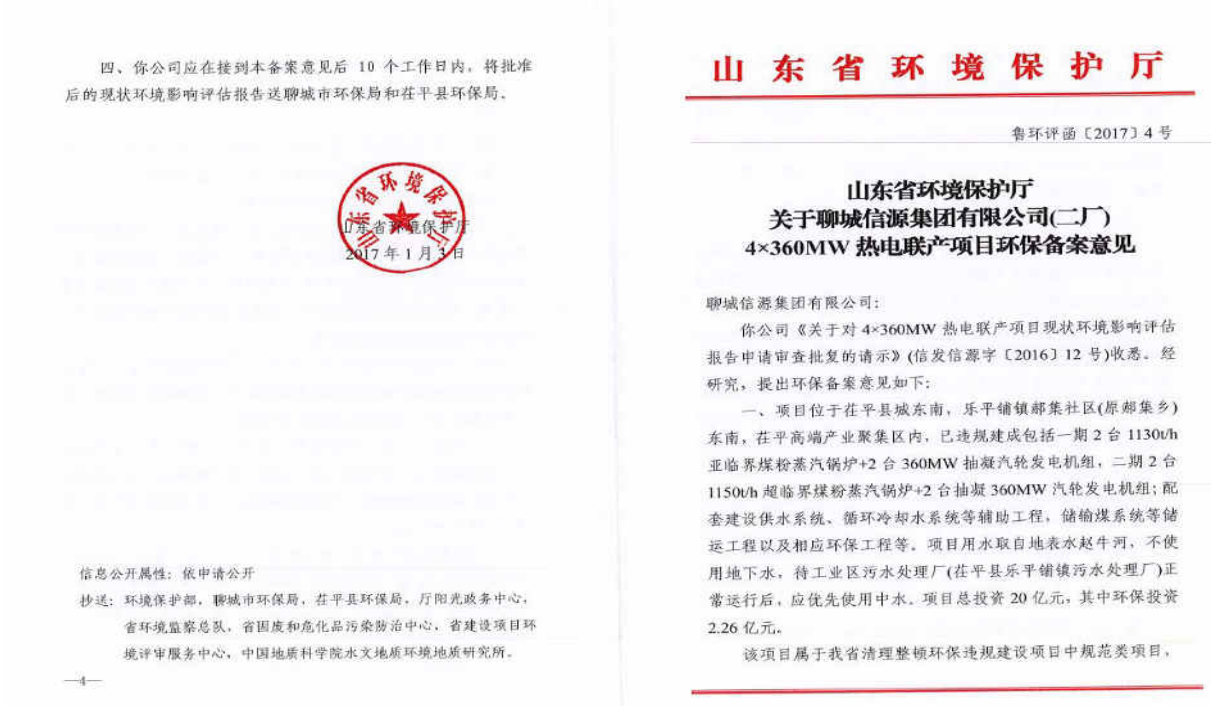
22. During the audit, the team reviewed the systems used by Haoji Power Plant for chemicals management which emphasizes the need for obtaining and retaining a Material Safety Data Sheet (MSDS) for each chemical stored and/or used on site, and providing employee access to this information. Haoji Power Plant has now installed a computerized system for keeping the MSDS records. For hazardous materials and hazardous wastes, Haoji Power Plant keeps copies of permits and licenses for all handlers that deliver or remove such materials.

D. Compliance for Standards, Approvals, and Permits Requirements

1. EIA and environmental acceptance

23. Before 2016, the Haoji Power Plant did not comply with PRC EIA requirements. In 2016, Haoji Power Plant prepared an EIA report and submitted the report to Shandong Provincial EPB for approval. The EIA was approved by Shandong Provincial EPB in January 3, 2017.

Figure 6: EIA approvals



四、你公司应在接到本备案意见后 10 个工作日内，将批准后的现状环境影响评估报告送聊城市环保局和茌平县环保局。

山东省环境保护厅
2017 年 1 月 3 日

信息公开属性：依申请公开

抄送：环境保护部，聊城市环保局，茌平县环保局，厅阳光政务中心，省环境监察总队，省固废和危化品污染防治中心，省建设项目环境评审服务中心，中国地质科学院水文地质环境地质研究所。

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山 东 省 环 境 保 护 厅

鲁环评函〔2017〕4 号

山东省环境保护厅
关于聊城信源集团有限公司(二厂)
4×360MW 热电联产项目环保备案意见

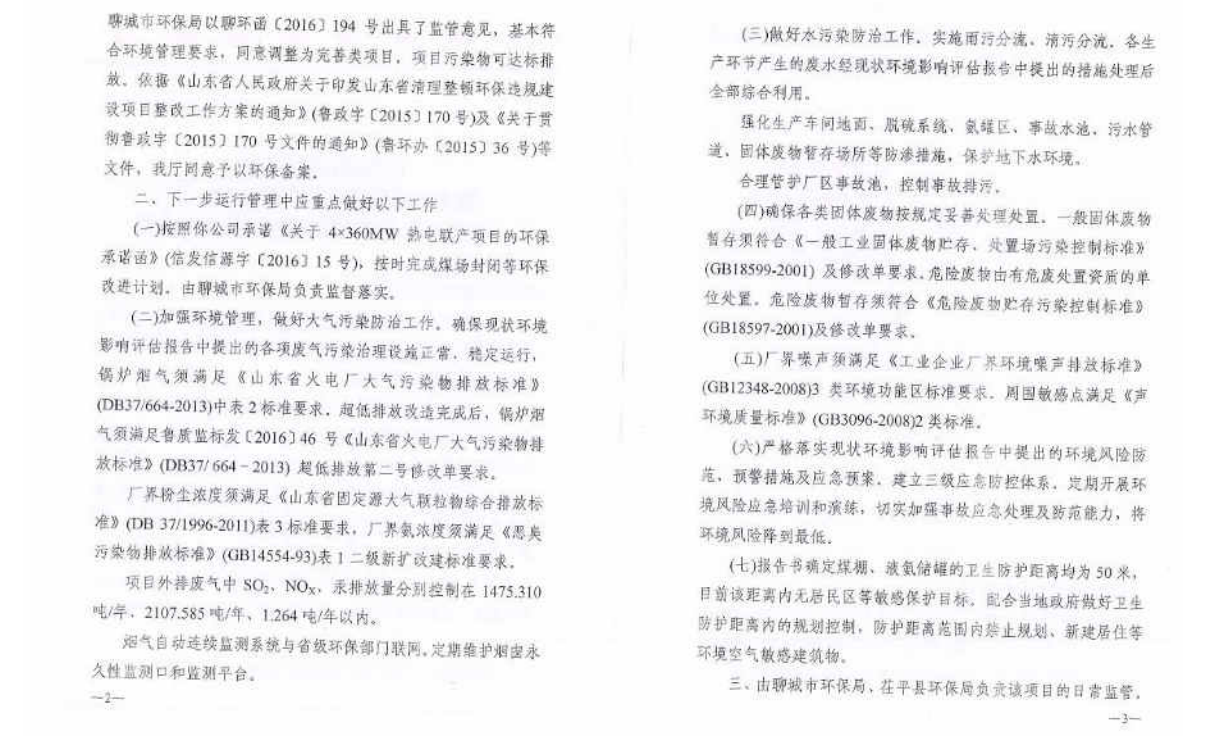
聊城信源集团有限公司：

你公司《关于对 4×360MW 热电联产项目现状环境影响评估报告申请审查批复的请示》(信发信源字〔2016〕12 号)收悉。经研究，提出环保备案意见如下：

一、项目位于茌平县城东南，乐平铺镇郝集社区(原郝集乡)东南，茌平高端产业聚集区内，已违规建成包括一期 2 台 1130t/h 亚临界煤粉蒸汽锅炉+2 台 360MW 抽凝汽轮发电机组，二期 2 台 1150t/h 超临界煤粉蒸汽锅炉+2 台抽凝 360MW 汽轮发电机组；配套建设供水系统、循环冷却水系统等辅助工程，储输煤系统等储运工程以及相应环保工程等。项目用水取自地表水赵牛河，不使用地下水，待工业区污水处理厂(茌平县乐平铺镇污水处理厂)正常运行后，应优先使用中水。项目总投资 20 亿元，其中环保投资 2.26 亿元。

该项目属于我省清理整顿环保违规建设项目中规范类项目，

Page 1



聊城市环保局以聊环函〔2016〕194 号出具了监管意见，基本符合环境管理要求，同意调整为完善类项目，项目污染物可达标排放。依据《山东省人民政府关于印发山东省清理整顿环保违规建设项目整改工作方案的通知》(鲁政字〔2015〕170 号)及《关于贯彻鲁政字〔2015〕170 号文件的通知》(鲁环办〔2015〕36 号)等文件，我厅同意予以环保备案。

二、下一步运行管理中应重点做好以下工作

(一)按照你公司承诺《关于 4×360MW 热电联产项目的环保承诺函》(信发信源字〔2016〕15 号)，按时完成煤场封闭等环保改进计划，由聊城市环保局负责监督落实。

(二)加强环境管理，做好大气污染防治工作，确保现状环境影响评估报告中提出的各项废气污染治理设施正常、稳定运行，锅炉烟气须满足《山东省火电厂大气污染物排放标准》(DB37/664-2013)中表 2 标准要求，超低排放改造完成后，锅炉烟气须满足鲁质监标发〔2016〕46 号《山东省火电厂大气污染物排放标准》(DB37/ 664－2013) 超低排放第二号修改单要求。

厂界粉尘浓度须满足《山东省固定源大气颗粒物综合排放标准》(DB 37/1996-2011)表 3 标准要求，厂界氨浓度须满足《恶臭污染物排放标准》(GB14554-93)表 1 二级新扩改建标准要求。

项目外排废气中 SO_2、NO_X、汞排放量分别控制在 1475.310 吨/年、2107.585 吨/年、1.264 吨/年以内。

烟气自动连续监测系统与省级环保部门联网。定期维护烟囱永久性监测口和监测平台。

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(三)做好水污染防治工作，实施雨污分流、清污分流，各生产环节产生的废水经现状环境影响评估报告中提出的措施处理后全部综合利用。

强化生产车间地面、脱硫系统、氨罐区、事故水池、污水管道、固体废物暂存场所等防渗措施，保护地下水环境。

合理管护厂区事故池，控制事故排污。

(四)确保各类固体废物按规定妥善处理处置。一般固体废物暂存须符合《一般工业固体废物贮存、处置场污染控制标准》(GB18599-2001) 及修改单要求。危险废物由有危废处置资质的单位处置。危险废物暂存须符合《危险废物贮存污染控制标准》(GB18597-2001)及修改单要求。

(五)厂界噪声须满足《工业企业厂界环境噪声排放标准》(GB12348-2008)3 类环境功能区标准要求。周围敏感点满足《声环境质量标准》(GB3096-2008)2 类标准。

(六)严格落实现状环境影响评估报告中提出的环境风险防范、预警措施及应急预案，建立三级应急防控体系，定期开展环境风险应急培训和演练，切实加强事故应急处理及防范能力，将环境风险降到最低。

(七)报告书确定煤棚、液氨储罐的卫生防护距离均为 50 米，目前该距离内无居民区等敏感保护目标，配合当地政府做好卫生防护距离内的规划控制，防护距离范围内禁止规划、新建居住等环境空气敏感建筑物。

三、由聊城市环保局、茌平县环保局负责该项目的日常监管，

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Source: Environment Specialist.

2. Relevant Environmental Standards

24. **Table 1** presents a summary of relevant emission standards for the Haoji Power Plant, which is more stringent than WHO Guidelines. **Table 2** presents the relevant ambient air quality standards for the Haoji Power Plant surrounding area. **Table 3** presents ambient noise standards. **Table 4** presents groundwater standards. Because the Haoji Power Plant will not discharge any wastewater to surface water body. No surface water standard is applicable.

Table 1: Summary of Environmental Pollution Standards Applicable to the Haoji Power Plant

Pollutant	Limit	Standards Source
Stack Emissions		
SO_2	35 mg/m^3	Ultra-low emission standards from *Energy conservation and emission reduction upgrade and transformation Plan for coal fired power station* (2014-2020)
NOx	50 mg/m^3	
PM	10 mg/m^3	
Other		
Fugitive PM	1.0 mg/m^3 at site boundary	Table 2 of *Integrated Emission Standard of Air Pollutants* (GB 16297-1996)
Daytime Noise (06:00-22:00 h)	65dB(A) at site boundary	Class III of *Emission Standard for Industrial Enterprises at Site Boundary* (GB 12348-2008)
Nighttime noise (22:00-06:00 h)	55dB(A) (at site boundary)	

Table 2: Applicable ambient air quality standards – Class II, Ambient Air Quality Standards (GB 3095—2012) (unit: mg/m^3)

Pollutants	Annual mean (class 2)	24-hr mean (class 2)	1-hr mean (class 2)
TSP	0.200	0.300	--
PM_{10}	0.070	0.150	--
$PM_{2.5}$	0.035	0.075	--
SO_2	0.060	0.150	0.500
NO_2	0.040	0.080	0.200

Table 3: Applicable ambient environment noise standard – Class III, Environmental Quality Standards for Noise (GB3096-2008)

Item	Class II	Class III
Daytime Noise (06:00-22:00 h)	60 dB(A)	65 dB(A)
Nighttime noise (22:00-06:00 h)	50 dB(A)	55 dB(A)

Table 4: Applicable groundwater standard (Class III, *GB/T14848-2017 Quality Standard for Ground Water*)

No	Item	Unit	Limit
1	pH	-	6.5-8.5
2	Total hardness ($CaCO_3$)	mg/L	≤450
3	Fluoride	mg/L	≤1.0

4	Chloride	mg/L	≤250
5	Ammonia nitrogen	mg/L	≤0.2
6	Nitrate	mg/L	≤20
7	Nitrite	mg/L	≤0.02
8	Volatile Phenols	mg/L	≤0.002
9	Total dissolved solids	mg/L	≤1000
10	Permanganate index	mg/L	≤3.0
11	Total coliforms	/L	≤3.0

3. Environmental Monitoring

25. The Haoji Power Plant is equipped with a continuous emissions monitoring systems (CEMS) that monitors in real time SO_2, NOx, PM and air flow. Data is sent electronically to the Shandong EPB Data Center. Shandong EPB monitors the CEMS data, and staff indicates that Jinan EPB can be on site within as little as 1 hour if the CEMS indicates serious noncompliance. Emissions from Haoji Power Plant met the ultra-low emission standards.

26. Manual stack emissions monitoring is also undertaken on a quarterly basis by Jinan EPB for calibration. 3rd party company is also hired by the Haoji Power Plant on a quarterly basis for calibration. Internal monitoring of stack emission operational parameters is also implemented which are used to manage operation.

27. Noise monitoring is undertaken at the site boundary on a quarterly basis. Noise emission met the PRC standards.

4. Emission Controls and Compliance

28. All boilers are equipped with low-NOx burner, SCR denitrification, limestone and gypsum FGD equipment, bag filters and electrostatic precipitators. The plant is reported as being in full compliance with the current *Emission Standard of Air Pollutants for Thermal Power Plants* (GB 13223—2011) and ultra-low emissions standard from *Energy conservation and emission reduction upgrade and transformation Plan for coal fired power station (2014-2020)*. The EIA approvals show that Haoji Power Plant can meet the requirements. Liaocheng EPB was consulted by the consultant to identify for compliance with the PRC requirements during the site visit, no grievance was received or exceedance of standards occurred in the last two years.

29. Fugitive emission control measures are listed below:

(i) Coal storage site is closed and installed with spray equipment which sprays water periodically;

(ii) Fly ash and coal slag are mixed with water then transported for onsite treatment;

(iii) Fly ash, gypsum and coal slag are stored at storage site. This site is installed with spray equipment which sprays water periodically. In strong wind weather, water spray frequency will be increased.

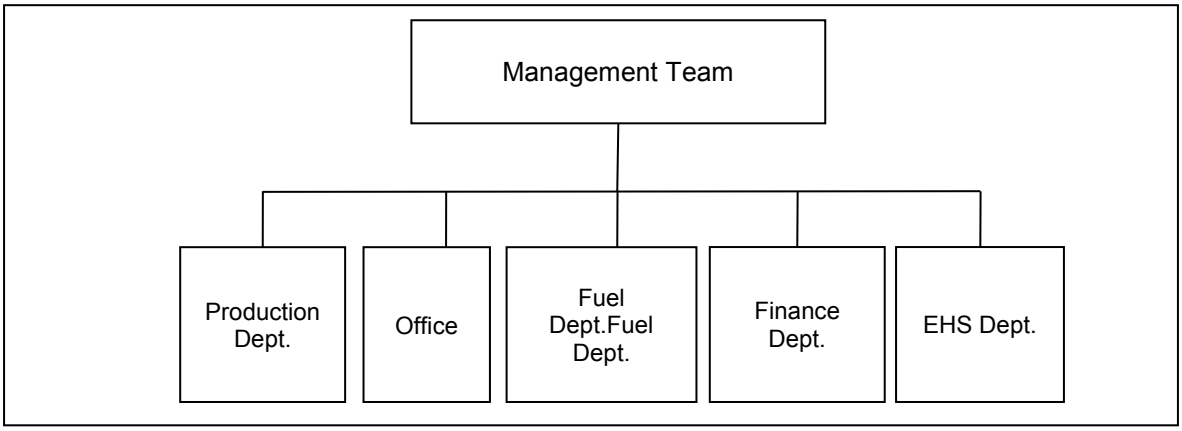
E. Environmental Management

1. ISO Certification, Staffing and Environmental Management

30. The Haoji Power Plant has a total of 230 staff. Environmental, health and safety (EHS)

responsibilities are assigned to the EHS Department, which has a staff of 40 and 12 staff is responsible for environment, 10 staff is for health and 18 is for safety. (**Figure 8**).

Figure 7: Organization structure of Haoji Power Plant



31. This structural arrangement aims to ensure EHS issues are well incorporated in other aspects like technical, finance, and others. All EHS staff have regular meeting with the head of EHS department for close coordination and effective implementation of EHS management systems. The site has an EHS Committee that meets regularly to discuss progress and set targets and objectives going forward.

2. Staff training and PPE provision

32. Haoji Power Plant organizes various types of safety education and trainings for employees. Also, external construction personnel receive EHS trainings from Haoji Power Plant.

33. In 2017, Haoji Power Plant provided EHS training to 516 person- time. Haoji Power Plant provides employees with Personal Protective Equipment (PPE) that is essential for performing work activities safely. During the audit visit, at the entrance of the site, a full range of PPE was provided to the audit team. The workers on-site were all wearing proper PPEs. Thus, the audit can confirm that PPE provision and implementation is strictly followed as designed.

34. Haoji Power Plant maintains a comprehensive Emergency Response capability that includes an onsite Fire Department trained for a full range of emergencies that may occur at the plant. Haoji Power Plant also has a detailed Emergency Response Plan (ERP). The ERP is tested regularly with drills, simulations, and exercises. The staff reported that there was no accidents occurred in the last two years.

35. For some tank areas, such urea tank and hydrochloric acid tank, Haoji Power Plant has configured spare (reserved) tanks, cofferdams and emergency accident collecting pools to timely perform relative treatments in case of leakage occurrence, which meet the World Bank EHS guidelines requirements.

F. Conclusion

36. The audit confirmed that the EHS management systems were comprehensive and there was clear evidence of continual improvement. The audit confirmed that senior management and employees have sincere commitment to EHS.

37. Based on this rapid environmental audit and due diligence, it can be concluded:

(i) the Haoji Power Plant has undergone an appropriate EIA process by Shandong EPB and has received the necessary EIA approvals and environmental acceptance approvals;

(ii) EHS polices and systems are in place and the respective EHS management programs were effective;

(iii) Comprehensive environmental monitoring programs were in place;

(iv) Combustion products are recycled into construction materials, and wastewater is recycled on site;

(v) Hazardous waste is stored according to Standard for pollution control on hazardous waste storage (GB18599- 2001, revised in 2013), then transported and treated by certified company.

(vi) No corrective action plan is required.