Environmental Impact Assessment (Update)

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 (Biomass Combined Heating and Power Generation Component)

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

CURRENCY EQUIVALENTS

(as of 27 August 2018)

Currency Unit	–	Chinese Yuan (CNY)
CNY1.00	=	€ 0.1261
€1.00	=	CNY 7.9293

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
JNMIP	Jinan New Material Industrial Park
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
SCADA	Supervisory Control and Data Acquisition
SCR	Selective Catalytic Reduction
SNCR	Selective Non-catalytic Reduction
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

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 environmental impact assessment (EIA) report has been prepared for the proposed biomass combined heating and power generation (CHP) 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 provide district heating services to Jinan New Material Industrial Park (JNMIP) by multiple heating sources to ensure secure and efficient heat supply, including a biomass CHP plant and geothermal energy. The component will provide district heating to 1.536 million m^2 area of which, 614,400 m^2 is residential area and 921,600 m^2 is industrial park area and produce power which is sold to the Grid. Through energy saving and integration of clean and renewable energy sources, the component will replace inefficient coal fired heating boilers thereby reducing ambient air pollution 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 EIA.

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) 2×75 t/h high pressure and high temperature biomass circulating fluidized bed (CFB) boilers with 2x15 MW extraction condensing turbines; (ii) 57.109 km of secondary heating network; and (iii) two geothermal wells (one producing well and one disposal well). Once completed, the component will provide 510,624 GJ of heating to an area of 1.536 million m^2 and produce 13.30253 million kWh power to the Grid annually.

E. Construction Schedule

7. The total construction period for the Project will be approximately 5 years.

F. Description of the Environment

i. Location and Topography

8. The component is located in JNMIP, Tianqiao District, Jinan City of 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.

ii. 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.

iii. Water Resources

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

iv. Ecological and Sensitive Resources

12. The component site is located in JNMIP. Surrounding land uses include industrial, 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.

v. 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.

vi. 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 Hi-tech Industrial Development Zone. 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, disruption of traffic and community services, and risks to worker 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 pollution, 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 and power production from coal-fired power plants. When compared to the equivalent production of heat and power through traditional coal-fired sources, once operational, the project will: (i) result in annual energy savings equivalent to 63,374.4 tons of coal equivalent (tce), thereby avoiding annual emissions of 168,524.25 tons of carbon dioxide (CO_2), a greenhouse gas; (ii) improve local air quality through the estimated annual reduction of emissions of sulfur dioxide (SO_2) by 87.86 tons, nitrogen oxides (NOx) by 39.85 tons, and particulate matter (PM) by 7.02 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. 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 in Jinan, and existing polluting small coal-fired boilers may continue to be used.

Based on an overall analysis of alternatives, the component has selected the most appropriate heat source, fuel type, biomass CFB boiler, geothermal resource 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 GHG emissions. It will also provide valuable experience in developing micro-energy grid to meet the increasing energy demand for heating. Its experience on mitigating some of the technology risks associated with micro-energy grid will be valuable as well.

I. Information Disclosure and Public Consultations

24. EIA Institute has undertaken two rounds of public consultation and 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 a public consultation meeting on 10 January 2017 before the preparation of the EIA. A public project information notice was posted in the nearby villages for two weeks prior to the meeting. The meeting was held in the office of Zhouyan village committee and 22 nearby villagers were invited to the meeting. During the meeting, information on the component construction content and status was presented by the JTPC while information on potential environmental impacts and proposed mitigation measures, GRM requirements of ADB and component benefits was presented by ADB's social consultant and environmental consultant. 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 meeting, most of the participants believed that the component can provide a clean district heating service and provide more job opportunities to the nearby villages and 100% of participants supported the construction of component.

26. During the EIA preparation process, after a draft EIA was prepared by JTPC, JTPC conducted survey in nearby villages in April 2018. A total of 240 questionnaires were distributed and 240 completed questionnaires were received. The main contents of the questionnaire are potential impacts and mitigation measures. Most of the respondents work and live within a 3 km radius of the project; 85.7% of respondents knew about project either from other person, newspapers or information signs, and 91.4% 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 (37.1%), surface water (17.1%) and noise (14.3%). 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.

27. The overall support for the project is very strong; 94.3% of the respondents indicated that the project will improve local economic development; 90.0% indicated that the project will improve quality of life; and 91.7% of respondents indicated that they support the proposed project.

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

J. Grievance Redress Mechanism

29. 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)

30. 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

31. 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

32. 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.

33. Overall, any minimal adverse environmental impacts associated with the component can be prevented, reduced, or minimized through the appropriate application of mitigation measures.

I. INTRODUCTION

A. The Project

1. This Environmental Impact Assessment (EIA) report is prepared for the proposed biomass Combined Heat and Power (CHP) component of the proposed Shandong Clean Heating and Cooling Project in Shandong Province of the People's Republic of China (PRC) (the Project) (**Figure I-1**). 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 provide district heating services to Jinan New Material Industrial Park (JNMIP) by multiple heating sources to ensure secure and efficient heat supply, including biomass combine heat and power (CHP) plant and geothermal energy. The component will provide district heating to 1.536 million m^2 of which, 614,400 m^2 are residential area and 921,600 m^2 are industrial park and produce power which is sold to the electric power grid. Through energy saving and integration of clean and renewable energy sources, the component will replace inefficient coal fired heat only boilers thereby reducing ambient air pollution in Jinan City.

3. The component will be implemented through four outputs:

(i) **Output 1**: One biomass CHP plant will be constructed with 2×75 t/h high pressure and high temperature biomass CFB boilers and 2x15 MW extraction condensing turbines;

(ii) **Output 2**: To demonstrate deep geothermal district heating system in Jinan especially around the component site, the proposed component will build two demonstration geothermal wells (one producing well and one disposal well) with a heat supply capacity of 1.2 MW to provide district heating to the biomass CHP plant (the heating area of the plant is 24,572 m^2). Temperature of ground water at the depth of 1,500-2,000 meters is around 60°C will be extracted for heat exchange. Heat exchange facilities such as heat exchangers, pumps and supporting pipelines will be financed by counterpart funding;[1]

(iii) **Output 3**: District heating pipeline network will be constructed. Total length of the pipeline is 57.109 km. The pipe networks will utilize two-pipe system. One is water supply pipe and another is water return pipe; and

(iv) **Output 4**: Strengthened capacity to install and maintain clean heating technologies. The component activities will employ women and include awareness raising about the benefits of clean energy targeted toward women who are often responsible for domestic upkeep.

4. The scope of the component includes: (i) 2×75 t/h high pressure and high temperature biomass CFB boilers with 2x15 MW extraction condensing turbines; (ii) 57.109 km of secondary heating network; and (iii) two geothermal wells (one producing well and one disposal well). Once

[1] Based on ADB SPS 2009, impacts of the heat exchange facilities and mitigation measures will be included in this EIA report.

completed, the component will provide heat 510,624 GJ to an area of 1.536 million m^2 and produce 13.30253 million kWh power to the electric power grid annually.

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. This report, including an environmental management plan (EMP) is prepared following both national regulations and ADB's environmental safeguard requirements specified in the Safeguard Policy Statement (SPS 2009). 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 environmental impact assessment (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; and site visits, surveys, consultations undertaken by ADB PPTA environmental consultants and ADB review mission discussions with the IA and relevant government agencies.

E. Report Structure

10. This EIA 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.

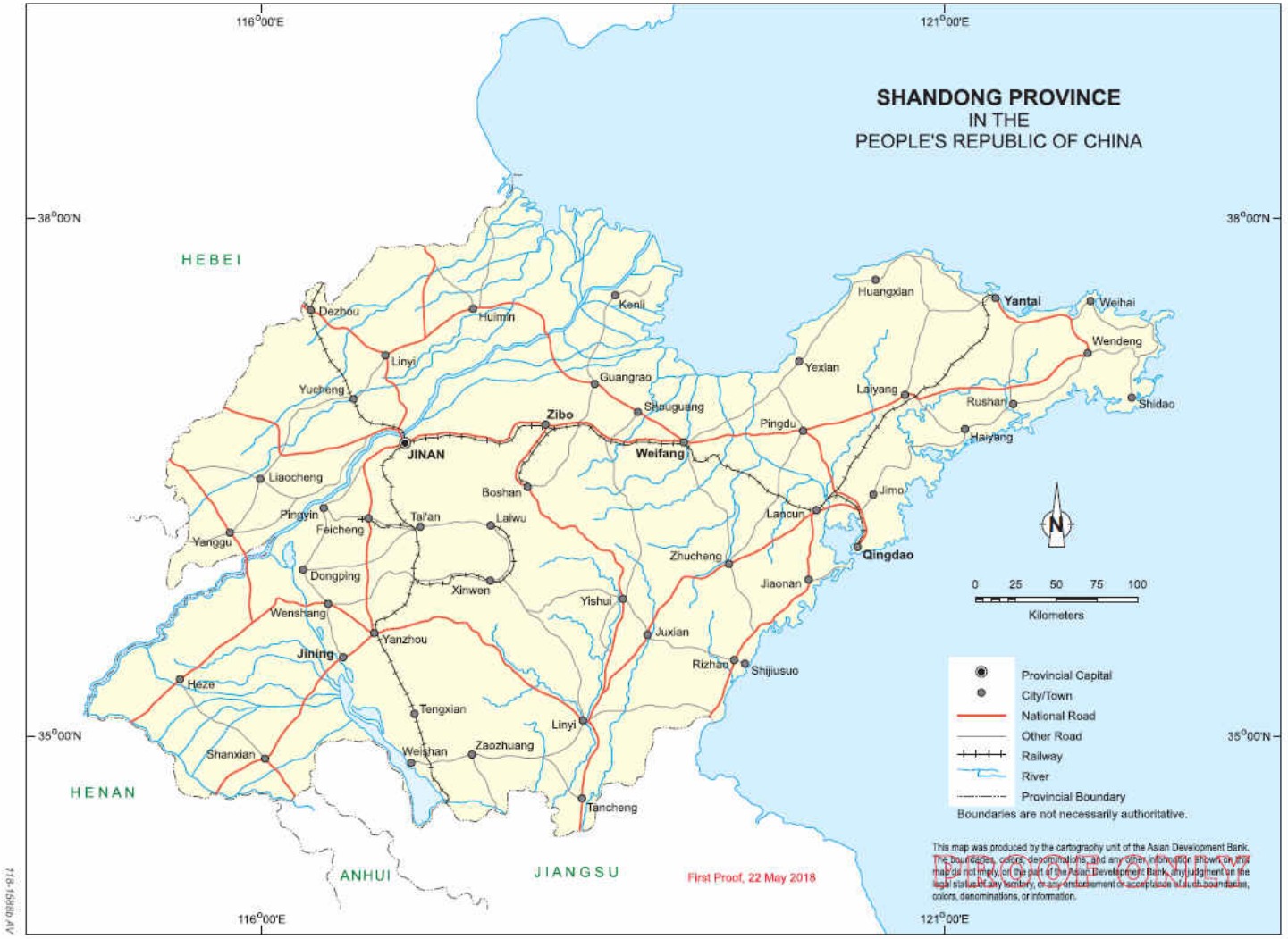
VIII Grievance Redress Mechanism
Describes the component grievance redress mechanism (GRM) for resolving complaints.

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, and coal and emission reduction factors and calculations.

Figure I-1: Jinan City, Shandong Province



II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

12. This EIA 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 EIA. 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 A and thus an EIA 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 EIA.

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*.[2] 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 listed in **Table II-2**.

[2] The guidelines applied for this component are Environmental, Health, and Safety General Guidelines, Environmental, Health, and Safety Guidelines for Thermal Power Plants, Environmental, Health, and Safety Guidelines for Geothermal Power Generation, Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution. These guidelines can be found at http://www.ifc.org/ehsguidelines

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" [3], 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
6	Water and Soil Conservation Law	2011

[3] 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.

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[4] of the project site as described in the directory. The directory provides detailed EIA requirements for 50 sectors

[4] 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 (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.

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
No.	**Guideline**	**Date**
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 2.2-2008 Technical Guidelines for EIA – Atmospheric Environment	2008
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

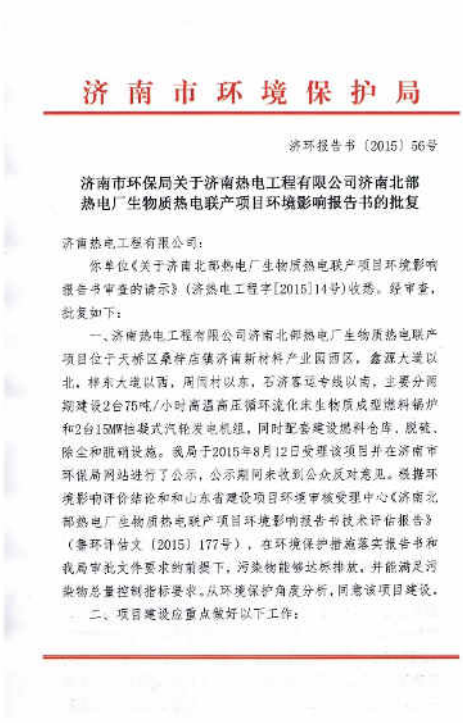
Source: ADB PPTA consultants.

D. Project Domestic EIA Report

35. Under MEE Decree on Management Guideline on EIA Categories of Construction Projects (MEP Decree 2017-44), the project requires a full EIA report. The domestic EIA report covering all components of the project was prepared by Shandong Harmony Project Consulting Co., Ltd, Jinan Division. The company is certified by the MEE to undertake category A, B, and C assessments.

36. The domestic EIA report was reviewed by Jinan EPB and formally approved by Jinan EPB on 1 December 2015. The EIA approval is presented in **Figure II-1**.

Figure II-1: Domestic EIA approval



济 南 市 环 境 保 护 局

济环报告书〔2015〕56号

济南市环保局关于济南热电工程有限公司济南北部热电厂生物质热电联产项目环境影响报告书的批复

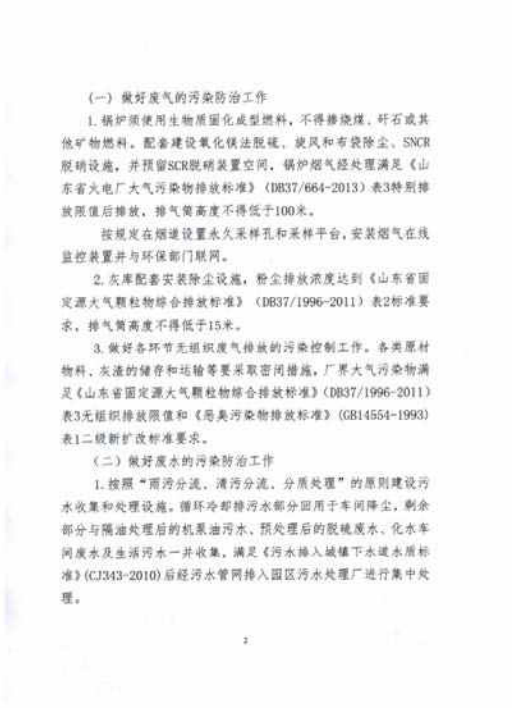
济南热电工程有限公司：

你单位《关于济南北部热电厂生物质热电联产项目环境影响报告书审查的请示》（济热电工程字[2015]14号）收悉。经审查，批复如下：

一、济南热电工程有限公司济南北部热电厂生物质热电联产项目位于天桥区桑梓店镇济南新材料产业园西区，鑫源大道以北，标东大道以西，周而村以东，石济客运专线以南，主要分两期建设2台75吨/小时高温高压循环流化床生物质成型燃料锅炉和2台15MW抽凝式汽轮发电机组，同时配套建设燃料仓库、脱硫、除尘和脱硝设施。我局于2015年8月12日受理该项目并在济南市环保局网站进行了公示，公示期间未收到公众反对意见。根据环境影响评价结论和和山东省建设项目环境审核受理中心《济南北部热电厂生物质热电联产项目环境影响报告书技术评估报告》（鲁环评估文〔2015〕177号），在环境保护措施落实报告书和我局审批文件要求的前提下，污染物能够达标排放，并能满足污染物总量控制指标要求。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：

Page 1



（一）做好废气的污染防治工作

1. 锅炉须使用生物质固化成型燃料，不得掺烧煤、矸石或其他矿物燃料。配套建设氧化镁法脱硫、旋风和布袋除尘、SNCR脱硝设施，并预留SCR脱硝装置空间，锅炉烟气经处理满足《山东省火电厂大气污染物排放标准》（DB37/664-2013）表3特别排放限值后排放，排气筒高度不得低于100米。

按规定在烟道设置永久采样孔和采样平台，安装烟气在线监控装置并与环保部门联网。

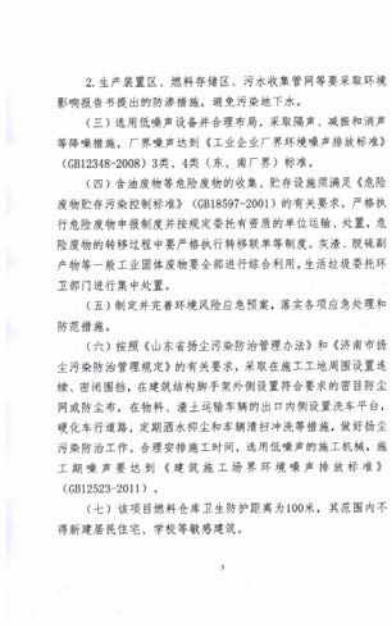
2. 灰库配套安装除尘设施，粉尘排放浓度达到《山东省固定源大气颗粒物综合排放标准》（DB37/1996-2011）表2标准要求，排气筒高度不得低于15米。

3. 做好各环节无组织废气排放的污染控制工作。各类原材物料、灰渣的储存和运输等要采取密闭措施，厂界大气污染物满足《山东省固定源大气颗粒物综合排放标准》（DB37/1996-2011）表3无组织排放限值和《恶臭污染物排放标准》（GB14554-1993）表1二级新扩改标准要求。

（二）做好废水的污染防治工作

1. 按照“雨污分流、清污分流、分质处理”的原则建设污水收集和处理设施。循环冷却排污水部分回用于车间降尘，剩余部分与隔油处理后的机泵油污水、预处理后的脱硫废水、化水车间废水及生活污水一并收集，满足《污水排入城镇下水道水质标准》（CJ343-2010）后经污水管网排入园区污水处理厂进行集中处理。

Page 2



2. 生产装置区、燃料存储区、污水收集管网等要采取环境影响报告书提出的防渗措施，避免污染地下水。

（三）选用低噪声设备并合理布局，采取隔声、减振和消声等降噪措施，厂界噪声达到《工业企业厂界环境噪声排放标准》（GB12348-2008）3类、4类（东、南厂界）标准。

（四）含油废物等危险废物的收集、贮存设施须满足《危险废物贮存污染控制标准》（GB18597-2001）的有关要求，严格执行危险废物申报制度并按规定委托有资质的单位运输、处置，危险废物的转移过程中要严格执行转移联单等制度。灰渣、脱硫副产物等一般工业固体废物要全部进行综合利用，生活垃圾委托环卫部门进行集中处置。

（五）制定并完善环境风险应急预案，落实各项应急处理和防范措施。

（六）按照《山东省扬尘污染防治管理办法》和《济南市扬尘污染防治管理规定》的有关要求，采取在施工工地周围设置连续、密闭围挡，在建筑结构脚手架外侧设置符合要求的密目防尘网或防尘布，在物料、渣土运输车辆的出口内侧设置洗车平台，硬化车行道路，定期洒水抑尘和车辆清扫冲洗等措施，做好扬尘污染防治工作。合理安排施工时间，选用低噪声的施工机械，施工期噪声要达到《建筑施工场界环境噪声排放标准》（GB12523-2011）。

（七）该项目燃料仓库卫生防护距离为100米，其范围内不得新建居民住宅、学校等敏感建筑。

Page 3

（八）燃料收集加工点和涉及电磁辐射的工程（设备）等另行向有审批权的环境保护行政主管部门报批环境影响评价文件。

三、项目建成后，二氧化硫、氮氧化物年总量分别控制在49.32吨、106.8吨之内。

四、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、同时投用的环境保护“三同时”制度。按规定的程序向我局申请建设项目竣工环保验收，经验收合格后方可正式投入使用。

五、天桥区环保局要加强对该建设项目的日常监督检查，市环境监察支队做好监察协查工作。

2015年12月1日

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37. Based on the requirements of ADB PPTA consultants, Shandong Harmony Project Consulting Co., Ltd updated the atmospheric dispersion modeling results, ambient air quality monitoring results and meteorological data to prepare this EIA report.

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 Quality 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 Groundwater	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
19	Organic Fertilizer Standards	NY525-2012

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.[5]

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.

5 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, μg/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

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 EIA report.

2. Combine Heat and Power (CHP) Plant Emissions

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

Table II-6: Relevant PRC and Shandong Province Thermal Power Plant Emission Standards and Relevant International Guidelines

Parameter	Emission Standards of Thermal Power Plants in China (Table 2 of GB 13223-2011)	Emission Standards of Thermal Power Plants in Shandong Province (Table 3 of DB 37/664－2013)	EHS Guidelines for Combustion Turbine (Table 6(B))	Comparison
Stack Height	Stack height is determined based on the requirements in the approved EIA, and must be > 8 m.	Stack height is determined based on 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.	
PM	20 mg/Nm^3	20 mg/Nm^3	30 mg/Nm^3	Shandong Province standard is more stringent than the EHS guidelines
SO_2	50 mg/Nm^3	50 mg/Nm^3	Use of 0.5% or less sulfur fuel[6]	Shandong Province standard and the EHS Guidelines are not directly comparable
NO_x	100 mg/Nm^3	100 mg/Nm^3	152 mg/Nm^3	Shandong Province standard is more stringent than the EHS guidelines

Source: WHO EHS Guideline for Thermal Power Plant, PRC GB 13223-2011 and DB 37/664－2013.

46. The component will install dust removal/collection equipment for ash warehouse and the particulate matter emission standard of the dust removal/collection equipment is regulated by Shandong Province's integrated particulate matter emission standard for stationary sources in Shandong Province (DB 37/1996-2011), which sets 30 mg/m^3 as the maximum allowable emission concentration at the outlet of the dust collection equipment. There is no equivalent standard recommended in the *EHS Guidelines,* and the PRC standard is adopted for use in this EIA report.

3. Odor pollutant

47. Odor pollutant generated from the component operation is regulated under PRC's Emission standards for Odor Pollutants (GB 14554-93). There is no equivalent standard recommended in the *EHS Guidelines,* and the PRC standard is adopted for use in this EIA report.

[6] The sulfur content of the biomass briquettes used in this project is less than 0.5%.

Table II-7: Applicable odor pollutant standard

No.	Parameter	Category II Standard at the site boundary (mg/m^3, Odor concentration excluded)
1	Ammonia	2.0
2	Trimethylamine	0.15
3	H_2S	0.10
4	Methyl mercaptan	0.01
5	Dimethyl sulfide	0.15
6	Dimethyl disulfide	0.13
7	Carbon disulfide	5.0
8	Styrene	7.0
9	Odor concentration	30

Source: PRC GB 14554-93.

4. Fugitive Particulate Matter Emission

48. Fugitive emission of particulate matter such as dust from operation sites is regulated under Shandong Province's Integrated particulate matter emission standard for stationary sources in Shandong Province (DB 37/1996-2011), which sets 120 mg/m^3 as the maximum allowable emission concentration and $\leqslant$1.0 mg/m^3 as the concentration limit at the boundary of construction sites, with no specification on the particular matter's particle diameter. There is no equivalent standard recommended in the *EHS Guidelines,* and the PRC standard is adopted for use in this EIA report.

5. Surface Water

49. 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, Category IV water quality standard (see **Table II-8**) is applicable for the surface water near the project site which is Tuhai River which is used as general industrial 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 EIA report.

Table II-8: 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

No.	Parameter	Water Quality Category				
		I	II	III	IV	V
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

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.
Source: PRC GB3838-2002.

6. Groundwater

50. 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 near the biomass CHP Plant is primarily used for irrigation, the Category III standard is applicable (**Table II-9**). There is no equivalent standard recommended in the *EHS Guidelines,* and the PRC standard is adopted for use in this EIA report.

Table II-9: 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
11	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

No.	Parameter	Unit	Category III Standard
22	Benzene	mg/l	0.01
23	Methylbenzene	mg/l	0.7
24	Total coliforms	/L	3.0
25	Colony forming unit	/L	100
26	Mercury	mg/l	0.001
27	Total dissolved solid	mg/l	1000

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.
Source: PRC GB/T14848-2017.

7. Wastewater Discharge

51. **Table II-10** 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.

52. The component will discharge wastewater to the municipal sewer systems for treatment at existing wastewater treatment plant (WWTP) of JNMIP. This WWTP treated all the domestic and industrial wastewater in JNMIP and is about 1.2 km away from the biomass CHP site. 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-10: 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.

8. Noise

53. **Table II-11** 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 III standards are stringent than WHO Class II standards. Because Category III standard is applicable to the component area and Category II standard is applicable to the nearby sensitive receptors, Category III for component area and Category I for sensitive receptors are utilized in this EIA report.

Table II-11: 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.

54. **Table II-12** presents the relevant PRC and international 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 EIA report. **Table II-12** resents the relevant PRC and international standards (US EPA, IFC EHS Guideline: Occupational health and safety standards) for on-site construction noise. 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-12: 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.

55. 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-13**).

Table II-13: 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

56. This component will provide district heating services to JNMIP and nearby residential areas by multiple heating sources to ensure secure and efficient heat supply, including biomass CHP plant and geothermal energy. The component will provide district heating to 1.536 million m^2 of which, 614,400 m^2 are residential area and 921,600 m^2 are industrial park and produce power which is sold to the electric power grid. Through energy saving and integration of clean and renewable energy sources, the component will reduce ambient air pollution in Jinan City.

57. The component will be implemented through four outputs:

(i) **Output 1**: One biomass CHP plant will be constructed with 2×75 t/h high pressure and high temperature biomass CFB boilers and 2x15 MW extraction condensing turbines;

(ii) **Output 2**: To demonstrate deep geothermal district heating system in Jinan especially around the component site, the proposed component will build two demonstration geothermal wells (one producing well and one disposal well) with a heat supply capacity of 1.2 MW to provide district heating to the biomass CHP plant (the heating area of the plant is 24,572 m^2). Temperature of ground water at the depth of 1,500-2,000 meters is around 60°C will be extracted for heat exchange. Heat exchange facilities such as heat exchangers, pumps and supporting pipelines will be financed by counterpart funding;

(iii) **Output 3**: District heating pipeline network will be constructed. Total length of the pipeline is 57.109 km. The pipe networks will utilize two-pipe system. One is water supply pipe and another is water return pipe; and

(iv) **Output 4**: Strengthened capacity to install and maintain clean heating technologies. The component activities will employ women and include awareness raising about the benefits of clean energy targeted toward women who are often responsible for domestic upkeep

58. The component scope includes: (i) 2×75 t/h high pressure and high temperature biomass CFB boilers with 2x15 MW extraction condensing turbines; (ii) 57.109 km of secondary heating network; and (iii) two geothermal wells (one producing well and one disposal well) with a district heating supply capacity of 55,000 m^3. Once completed, the component will provide heat 510,624 GJ to an area of 1.536 million m^2 and sell 13.30253 million kWh power to the electric power grid annually.

59. The component impact will be 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

60. The component will be implemented at Tianqiao District 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

61. The component is located in JNMIP, Tianqiao District of Jinan City (**Figure III-2**).

Figure III-2: Biomass CHP location

Source: Google earth, 2018.

C. Project Rational

62. 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.

63. 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.

64. 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).

65. 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.[7] 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.[8]

66. 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).[9] 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.

67. 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.

68. 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.

69. Development of cleaner, innovative heating and cooling systems are stymied by their high upfront capital costs. Smaller biomass boilers, on the other hand, have much higher investment costs per kilowatt (kW) capacity compared to larger boilers since they do not benefit from

[7] HKTDC Research. Shandong: Market Profile. Accessed March 22, 2018.
[8] 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.
[9] Jinan EPB. 2017. *The 2017 Bulletin on the Jinan Municipal Air Quality*. Jinan.

economies of scale.[10]

70. Instead of a conventional large scale heating system, the component aims to provide district heating to 1.536 million m^2 by biomass CHP and deep geothermal wells. The component is more flexible allowing (i) the use of different clean and renewable energy sources; and (ii) co-generation so that the systems can provide not only heating but also electricity to end-users who are not currently covered by existing district heating networks.

71. When compared to the equivalent production of heat and power through traditional coal-fired sources, once operational the project will: (i) result in annual energy savings equivalent to 63,374.4 tons of coal equivalent (tce), thereby providing a global public good by avoiding the annual emission of 168,524.25 tons of CO_2; (ii) improve local air quality through the estimated annual reduction of emissions of SO_2 by 87.86 tons, NOx by 39.85 tons, and PM by 7.02 tons; and (iii) eliminate the negative impacts of coal transportation through urban areas by truck or train.

D. Project Scope

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

Table III-1: Project Components and Key Features

No.	Component	Characteristics and Special Features
1	Main work	2×75 t/h high pressure and high temperature biomass CFB boilers. Boiler efficiency is no less than 88%. 2x15 MW extraction condensing turbines. Type is C15-8.83/0.294. 2x18 MW generators. Type is QF-18-2
2	Water supply system	Production water is treated reclaimed water which is from WWTP of JNMIP. One DN250 reclaimed water pipeline with a length of 1.2km will be built. Pre-treatment process of reclaimed water is flocculent precipitate+ sand filter + ultra-filtration. Treatment capacity is 200 m^3/h. Sludge generated from pretreatment process will be sold to be recycled as construction materials. The pre-treated reclaimed water will be used in desulfurization system, denitrification system, circulation cooling system and chemical water treatment system. Chemical water treatment process is multi-media filter + ultra-filtration + two stage reverse osmosis + electro deionization. Domestic water is from municipal water supply system.
3	Water drainage system	Storm water drainage system is separate from wastewater drainage system (domestic wastewater and production wastewater). Production wastewater will be recycled as much as possible. Wastewater drainage system is connected to WWTP of JNMIP.
4	Circulation cooling system	One counter flow natural ventilation hyperbola cooling tower with a water drenching area of 1200m^2. Maximum circulation water flow is 6340 m^3/h. Circulation ratio is 65 in summer and 45 in winter.

[10] International Energy Agency and Tsinghua University. 2017. *District Energy Systems in China: Options for Optimization and Diversification.* Paris.

No.	Component	Characteristics and Special Features
5	Boiler water treatment system	Make up water of boiler is from chemical water treatment process. Treatment capacity is 40 m^3/h.
6	Air and slag treatment system	Fly ash is collected by dust collection equipment and stored in ash warehouse (500 m^3). Slag is cooled down by slag cooler and stored in slag warehouse (100 m^3). A 1,000 m^3 warehouse will be built for temporary ash and slag storage. All ash and slag will be sold and reused as fertilizer. The fertilizer must meet the PRC Organic Fertilizer Standards (NY525-2012).
7	Fuel storage system	One 10,000 m^3 biomass fuel warehouse which can provide enough fuel to boilers to operate continuously for 10 days under maximum load.
8	Desulfurization and denitrification system	One 30 m^3 urea warehouse for selective non-catalytic reduction (SNCR) denitrification and one 30 m^3 magnesium oxide warehouse for desulfurization. Desulphurization by-product will be treated by filter-press and then sold and recycled as construction materials.
9	Exhaust gas treatment system	Exhaust gas from CFB boilers (the turbines will not generate exhaust gas) will be treated by SNCR denitrification system, magnesium oxide desulfurization, cyclone dust collector and bag filter, and then discharged through one 100m high stack with an inner diameter of 3 m at the outlet.
10	Accident tank	One 500m^3 accident tank for emergency wastewater storage.
11	Geothermal well system	One producing well and one disposal well. Heating supply capacity is 1.2 MW. Water flow is 60 m^3/h and water temperature is around 60°C.
12	Power distribution equipment	10 kV power distribution equipment and 35 kV power transformation equipment will be installed. One 2 km power distribution line will be lain in existing underground cable trench owned by Shandong Electric Power Group Corporation.
13	District heating pipeline network	Total length of the district heating pipeline is 57.109 km. Pipe diameters are from DN200 to DN1000.

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

Table III-2: Project Key Parameters

No.	Parameter	Unit	No.
1	Annual biomass consumption	thousand tons	155.5
2	Annual heat supply	GJ	510,624
3	Annual power generation	thousand kWh	133,025.3
4	Operation hours of power generating units	hours	5,000
5	Heat-to-electric ratio	%	93.79

No.	Parameter	Unit	No.
6	Unit biomass consumption	kg/kWh	1.17
7	Annual standard coal savings	tons	63,040.15

E. Implementation Arrangements

74. SPG will be the EA and responsible for overall guidance during project preparation and implementation. JTPC and Jinan Heating Group, two state-owned companies will be IA and responsible for implementing project components and administering and monitoring contractors and suppliers. 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. Key features of the component are listed below:

1. Energy Efficiency and Environmental Improvement

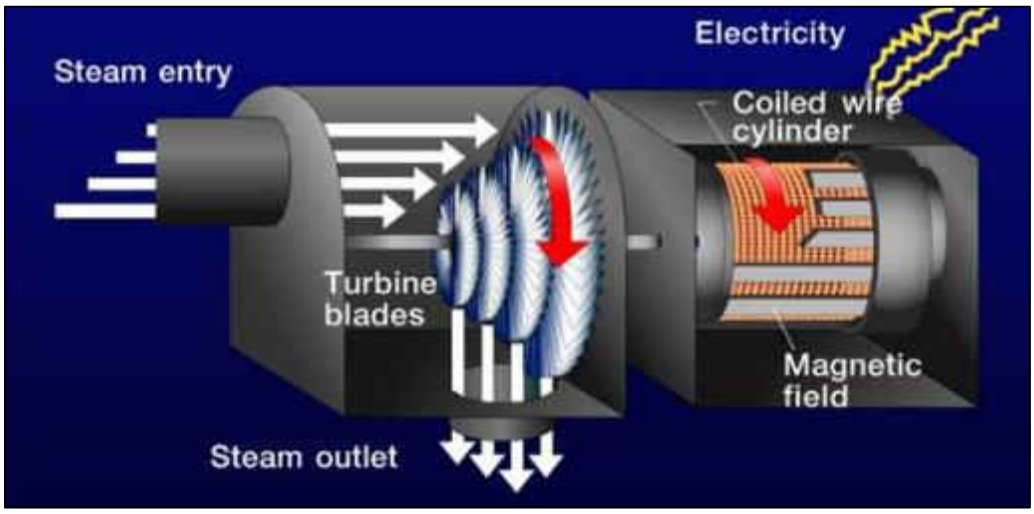
75. Overall, the component is expected to improve the energy efficiency and environmental performance of the heating sector compared to small and separate coal fired boilers. When compared to the equivalent production of heat and power through traditional coal-fired sources, once operational the project will: (i) result in annual energy savings equivalent to 63,374.4 tons of tce, thereby providing a global public good by avoiding the annual emission of 168,524.25 tons of CO_2; (ii) improve local air quality through the estimated annual reduction of emissions of SO_2 by 87.86 tons, NOx by 39.85 tons, and PM by 7.02 tons; and (iii) eliminate the negative impacts of coal transportation through urban areas by truck or train.

2. Combined heat and power

76. Combined heat and power (CHP) is the use of a heat engine or power station to generate electricity and useful heat at the same time. CHP has a highly efficient use of fuel because waste heat from electricity generation is used for heating.

77. A steam turbine is a device that extracts thermal energy from pressurized steam and uses it to do mechanical shaft rotating work. As the turbine generates rotary motion, it used to drive an electrical generator. **Figure III-3** illustrates the configuration of a steam turbine generator.

Figure III-3: Steam turbine generator



78. For heating supply, this component will use low temperature circulating water direct supply method. Circulation water of condensers of generators will be used as supply and return water (supply water temperature is 62°C and return water temperature is 50°C) in secondary pipeline network which is directly connected to heat users. The heat exchange will be occurred in condensers of generators between circulation water and exhausted steam.

79. Under extreme weather conditions, steam in turbines can be extracted for heat supply as peak load regulation.

3. Biomass briquettes

80. When solid biomass is already in a suitable form (such as firewood), it can burn directly in a stove or furnace to provide heat or raise steam. When solid biomass is in an inconvenient form (such as sawdust, wood chips, grass, urban waste wood, agricultural residues), the typical process is to densify the biomass. This process includes grinding the raw biomass to an appropriate particulate size.

81. Biomass briquettes, mostly made of green waste and other organic materials, are commonly used for electricity generation, heat, and cooking fuel. These compressed compounds contain various organic materials, including wheat straw, corn straw and agricultural waste. The composition of the briquettes varies by area due to the availability of raw materials. The raw materials are gathered and compressed into briquette in order to burn longer and make transportation of the goods easier. These briquettes are very different from charcoal because they do not have large concentrations of carbonaceous substances and added materials.

82. Compared to coal, the biomass briquettes produce low net NOx, SO_2 and PM. The briquettes also produce low net total greenhouse gas emissions because the materials used are already a part of the carbon cycle. Detailed information for biomass briquettes is presented in section D of Chapter V.

Figure III-4: Straw briquettes

4. Circulating fluidized bed boiler

83. CFB is a combustion technology used to burn solid fuels. In its most basic form, fuel particles are suspended in a hot, bubbling fluidity bed of ash and other particulate materials (sand, limestone etc.) through which jets of air are blown to provide the oxygen required for combustion or gasification. The resultant fast and intimate mixing of gas and solids promotes rapid heat transfer and chemical reactions within the bed. FBC plants are capable of burning a variety of low-grade solid fuels, including most types of coal and woody biomass, at high efficiency and without the necessity for expensive fuel preparation (e.g., pulverizing). In addition, for any given thermal duty, FBCs are smaller than the equivalent conventional furnace, so may offer significant advantages over the latter in terms of cost and flexibility. 75 tons/h boiler is a very big boiler in China. Boiler efficiency is no less than 88% while the maximum efficiency is 90%. At present, the maximum biomass CFB boiler in China is 130 tons/hour.

84. The CFB is a developing technology to achieve lower emission of pollutants. During the combustion phase, upwards jets of air will cause the solid fuels to be suspended. This is to ensure the gas and solids will mix together turbulently for better heat transfer and chemical reactions. This circulated fluidized boiler is equipped with low-NOx burners and NOx production will be reduced. The fuel will be burnt at a temperature of 850°C to 950°C to reduce nitrogen oxide from forming. While burning, flue gas such as sulfur dioxide will be released. At the same time, sulfur-absorbing chemical such as limestone or dolomite will be used to mix with the fuel particles in the fluidization phase, which will absorb almost 95% of the sulfur pollutants.

85. Alternatively, the sulfur absorbing chemical and fuel will be recycled to increase the efficiency of producing a higher quality steam as well as lower the emission of pollutants. Therefore, it will be possible to use CFB technology to burn fuel in a much more environmentally friendly method as compared to other conventional technologies.

86. Biomass fired CFB boiler adopts patented technology membrane water-cooling wall structure, improved fuel crusher and screening system, combustion and heating efficiency is

greatly improved. CFB biomass boilers have the same advantages like other CFB boiler, such as high efficiency, good combustion performance, energy saving. Besides, it burns shaped biomass fuel, which can also provide heat or generate electricity purely use coal or biomass fuel. Biomass CFB boiler's fuels Include: Shaped biomass fuel, straw, agricultural waste, wood pellet/chips, sawdust, etc.

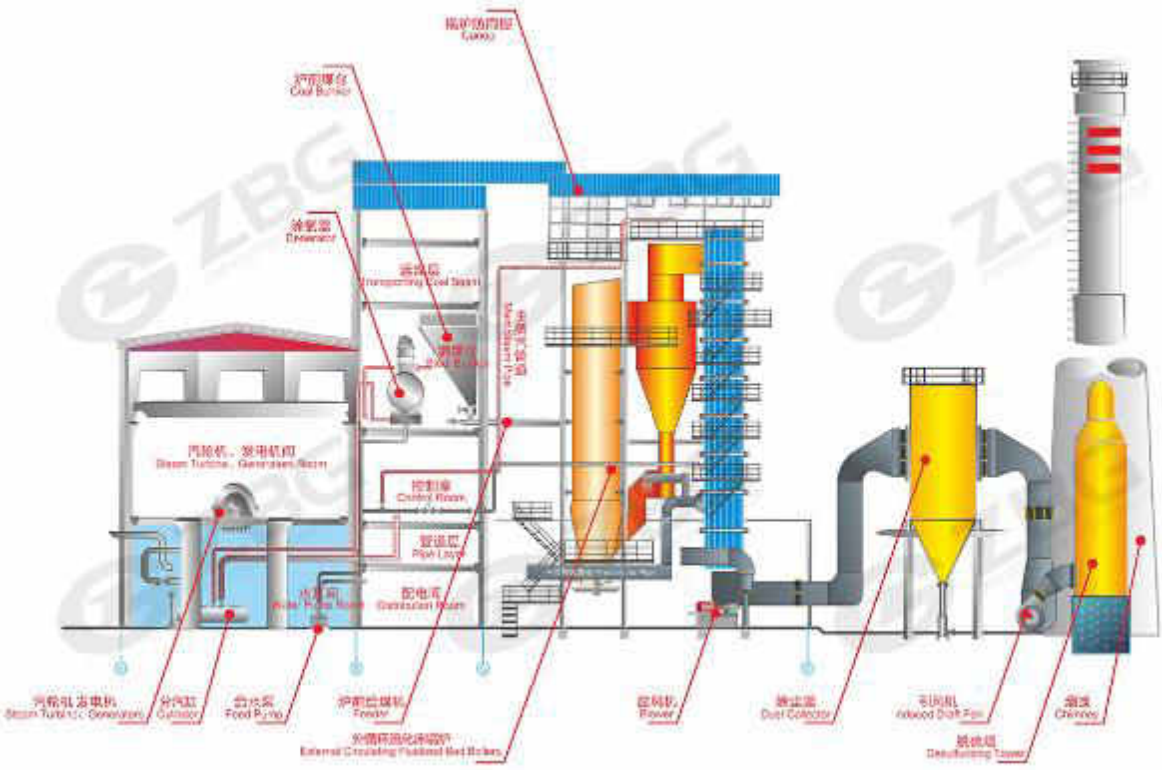
87. CFB biomass boiler have large combustion space and enough height to make sure the fuel has the sufficient time to burn in the furnace, meanwhile the adequate and stratified secondary air is deployed to fit in with the concentrated of volatile, so that guarantees the fuel and air are fully mixed to burn out in the furnace.

88. CFB biomass boiler is high combustion efficiency and cost savings, because: (i) the suspension furnace equipped with the water-cooled wall and the inlet of separator is water-cooled flue duct make it less heat-releasing and boiler-efficiency improvement; (ii) the separator and the center tube of loopback materials device have applied the technological improvements for low resistance, high separation efficiency, which ensure high combustion efficiency and low burn ash residual calorific value, savings cost.

89. Biomass fired CFB boiler's key features are presented below:

(i) Single drum in transverse type and "π" type layout;
(ii) Suspended type membrane water-cooling wall structure furnace and the gas passes make it less heat-releasing and clean;
(iii) Low resistance and high separating efficiency of separator and center cylinder ensure high combustion efficiency;
(iv) The technology of feeding device is adopted and the independent roots blower is equipped to provide wind so the power consumption is lowered;
(v) Low pressure fans used reduces the fan power consumption;
(vi) Optimization of the secondary air and the vents flow rate reduces the head of fan's secondary air pressure;
(vii) Improved fuel crushing and screening system makes the size of biomass particle conform to the designed requirements; and
(viii) Multi-tube box arrangement air preheater and low-temperature section adopts corrosion-resistant steel, which avoids the low-temperature corrosion.

Figure III-5: Biomass CFB Boiler



5. Low NOx boiler

90. A low NOx boiler is designed to optimize flame shape. Staged combustion technology is used, resulting in a cooler flame which suppresses thermal NOx formation. The swirl-stabilized primary area is responsible for producing a very stable flame. Combustion chambers are designed to match the low NOx burners. In addition, smart fuel-air compound control generates the optimum conditions for the combustion air through a joint fan with a frequency converter. The combination of low NOx combustion, large combustion chambers, smart control systems and efficient combustion technology benefits the environment as well as the operator and ensures that NOx emissions are less than 200 mg/m^3.

91. To meet the NOx emission concentration requirement (100 mg/m^3) in *Emission Standards of Thermal Power Plants in Shandong Province* (DB 37/664－2013), the boiler will be equipped with SNCR equipment. Considering the stricter emission standard in the future, space for selective catalytic reduction (SCR) equipment is reserved.

6. Deep geothermal energy

92. Geothermal energy is a clean and renewable energy source deriving from the exploitation of the heat flux reaching the surface from the deeper part of the Earth's crust. The heat can be utilized in space heating. There are two technical options for geothermal heating. One is shallow geothermal utilization and the other is deep-well geothermal utilization.

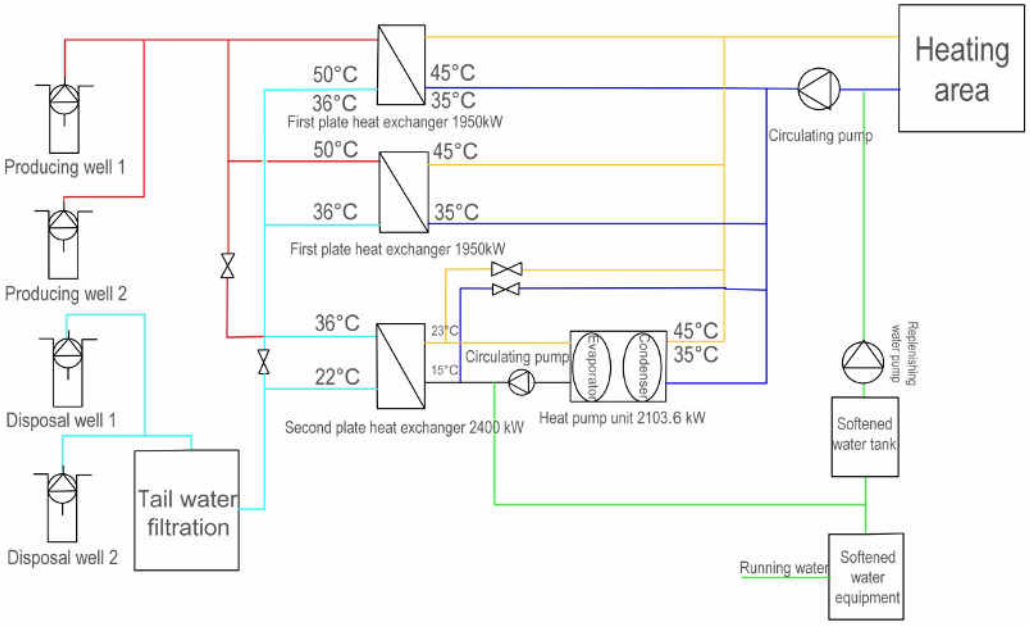
93. Shallow-ground source heating involves extracting geothermal energy from ground water

at around 16°C, via heat exchange tubes buried at a depth of 80 – 120 meters, then using a heat pump to increase the temperature to around 50°C. The advantages of this technology are: (i) deep drilling technology is not necessary, and there is minimal impact on groundwater resources; (ii) the coefficient of performance (COP) of Shallow-ground source heat pump is above 4, which is higher than those of air source heat pump or electric boiler, etc. (iii) detailed geothermal resource survey data is not necessary. However, this technology also has disadvantages, mainly is that multiple shallow wells may be needed to draw enough heat energy. Generally, the proportion of areas for buried tube against heating area is 1:3. Hence, it could not be used for large areas. Secondly, a large amount of electricity will still be consumed by the heat pump during the heating period. The power consumption is 39 kWh for heating per square meter per heating period (assuming 15 hours per day and 120 days per year). Thirdly, heating and cooling imbalance will lead to the decay of geothermal energy after long time of operation.

94. The other option, deep-well geothermal energy involves extracting ground water around 50 – 60°C at the depth of 1,000-2,000 meters, and heat exchanging via indirect counter current heat exchangers for heat supply. The water extracted from ground will then be filtered and recharged back underground. The whole system consists of geothermal well, pump room and pipe networks, among those the water pump is the only energy-consuming equipment. Compared to Shallow-ground source heat pump, deep-well geothermal energy has the tri-fold advantages of less land acquisition, stable heating and low maintenance cost. To make full use of the heat from ground water, heat pumps can be used to make the water to a higher temperature. However, the environmental risk of deep-well geothermal energy is the potential impact to underground water quantity and quality, so it is important to make sure that the extracted water is filtered and 100% recharged back. The ground water will be extracted and recharged in a closed system and no wastewater will be generated. Therefore, the component will not have impact to groundwater quantity and quality. Potential Shallow-groundwater contamination will be minimized by using leak-proof well casing in the injection wells.

95. Weighing between the two technologies explained above, the deep well geothermal energy can be used for direct district heating which is more efficient compared to Shallow-ground geothermal energy, thus the component is to adopt deep well geothermal energy technology for district heating. Flow chart of the component is presented in **Figure III-6**. Running water which is from the treated wastewater from the Wastewater Treatment Plant of Jinan New Material Industrial Park is utilized as make-up water of the secondary heating pipeline network. The volume of the running water is 70 m^3/h, while the volume of the make-up water is 1.4 m^3/h.

Figure III-6: Water Recharge Flow Chart



96. Based on domestic FSR, there are already four existing deep geothermal wells near the component site. Based on information from these wells, the depths of the wells are 1,810-1,875 m, temperatures of groundwater are 61-63°C, the flows are 1,300-1,746.08 m^3/d, hydrochemical types are Cl-Na type of Cl.SO4- Na type and salinity is 0.641-0.809 g/L. From the information, it can be concluded that deep geothermal energy near the component site can provide enough heat for the component.

7. Drilling fluid

97. In geotechnical engineering, drilling fluid is used to aid the drilling of boreholes into the earth. Often used while drilling oil and natural gas wells and on exploration drilling rigs, drilling fluids are also used for much simpler boreholes, such as water wells. The main functions of drilling fluids include providing hydrostatic pressure to prevent formation fluids from entering into the well bore, keeping the drill bit cool and clean during drilling, carrying out drill cuttings, and suspending the drill cuttings while drilling is paused and when the drilling assembly is brought in and out of the hole.

98. Drilling fluids employed during drilling activities may be water-or oil -based and may contain chemical additives to assist in controlling pressure differentials in the drill hole and to act against viscosity breakdown.

99. Compared to water-based fluid, oil-based fluid will contaminate areas of freshwater aquifers causing environmental damage and cuttings from oil-based mud are of particular concern due to the content of oil-related contaminants and may necessitate special on-site or off-site treatment in an appropriate place to isolate possible environmental contamination.

100. Oil-based fluids are expensive but are worth the cost when drilling through: (i) troublesome shales that would otherwise swell and disperse in water-based mud e.g. smectite, (ii) to drill deep, high-temperature holes that dehydrate water-based mud; (iii) to drill water-soluble zones; and (iv) to drill producing zones. There is no such area near the component site.

101. Based on the information above, the wells of the component will be 2,000 m depth and the temperature of ground water is around 60°C. Water-based drilling will be utilized because: (i) the geothermal at the component site is stored at sandstone reservoir which will have a stable wall during drilling; and (ii) the component will use high-pressure jet drilling technology and will use high speed (75-100 m/s) fluid to increase the drilling speed and clean the well and drilling pit. Water is a suitable fluid for this technology because water can help to remove the sand and slurry generated during drilling. There will be no chemicals added during the drilling process.

8. Drilling process

102. During drilling H_2S monitoring will be installed. If the level is over 5 ppm, the will be sealed and shut down. Before the drilling activities are started, drilling fluid circulation system with sand and slurry removal equipment and safety system will be installed.

103. When drilling starts, drilling fluid circulation system will be filled up with water. After drilling pipe is pulled out for 3-5 times, the system will be filled up with water again. During drilling, slurry and cuttings will be generated. Wastewater and cuttings will be collected and toxicity assessment will be conducted. Cuttings will be reused if they are non-toxic (e.g. as construction fill) or disposed of in a landfill facility and wastewater will be discharged to municipal sewer system. If toxicity is found, cutting and wastewater will be transported for treatment by a certified company. The mud pits shown in **Figure III-7** will be lined to prevent soil and groundwater contamination.

104. Slurry is calculated based on the formula below:

$V=1/4\pi D2h\times2\rho\times（1-\theta）$, in which:

V—— slurry quantity, m^3;

D——diameter, m;

h——depth, m:

θ——slurry recycling rate, for this component, θ is 80%;

ρ——slurry density, t/m^3 (based on the depth, for depth <2000m, ρ is 1.05)

105. Two geothermal wells will be installed. The wells are divided into two section: first section is 300m depth with a diameter of 400mm; second section is 1,500m depth with a diameter of 200mm. Slurry quantity of the component is 35.6 tons.

106. Cutting is calculated based on the formula below:

$V=1/4\pi D2h\times2\rho\times（1-\theta）$, in which:

V——Cuttings quantity,m^3;

D——diameter, m;

h——depth, m;

θ——porosity, for loose rocks is 0.25;

ρ——cutting density, 2.7t/m^3.

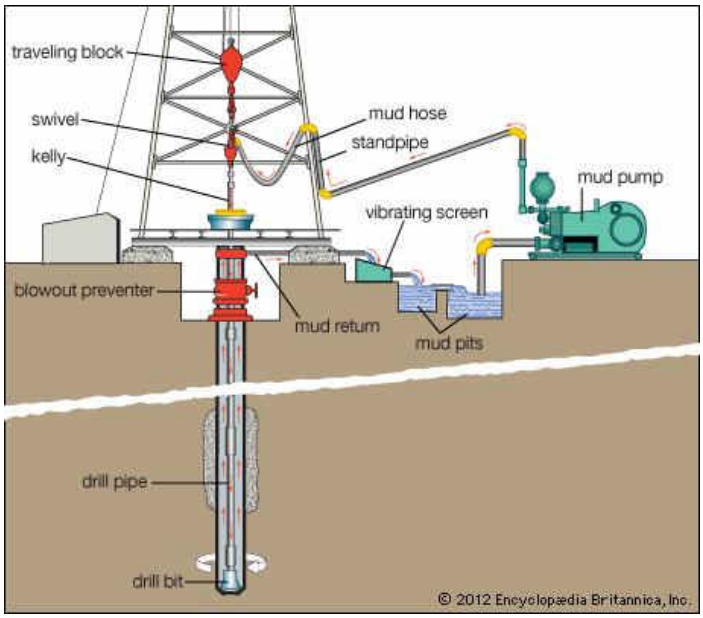
107. Two geothermal wells will be installed. The wells are divided into two section: first section is 300m depth with a diameter of 400mm; second section is 1,500m depth with a diameter of 200mm. Cutting quantity of the component is 343.5 tons.

108. Total slurry and cutting generated during drilling of the component will be 379.2 tons. Slurry and cutting will be collected by drilling company. After sedimentation, wastewater will be discharged to municipal sewer following the PRC standards. Rocks and sludge will be disposed at certified landfill site after drying.

109. The drilling speed will be controlled. If there is any accident occurs during the drilling, drilling will be stopped immediately and action plans will be implemented.

110. After the drilling is finished, the parameters of the well including water flow, temperature, depth, deflection will be monitored. Then the pipelines will be installed inside the well.

Figure III-7: Drilling equipment



9. Heating Pipelines

111. The component will utilize direct-buried pre-insulated bonded pipeline, which is by far the most commonly used technology for new district heating networks. 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 requirements, 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.

112. Pre-insulated plastic pipes will be used for secondary heating supply networks.

Construction of secondary networks is easier when bendable plastic pipes are used. The pipes will be direct-buried and will also utilize a twin-pipe system where both the supply and return pipes can be jacketed into one insulation sleeve. The diameters of the pipes are from DN200 to DN 1000. The supply water temperature will be 62°C, and the return water temperature will be 50°C.

F. Component Design Details

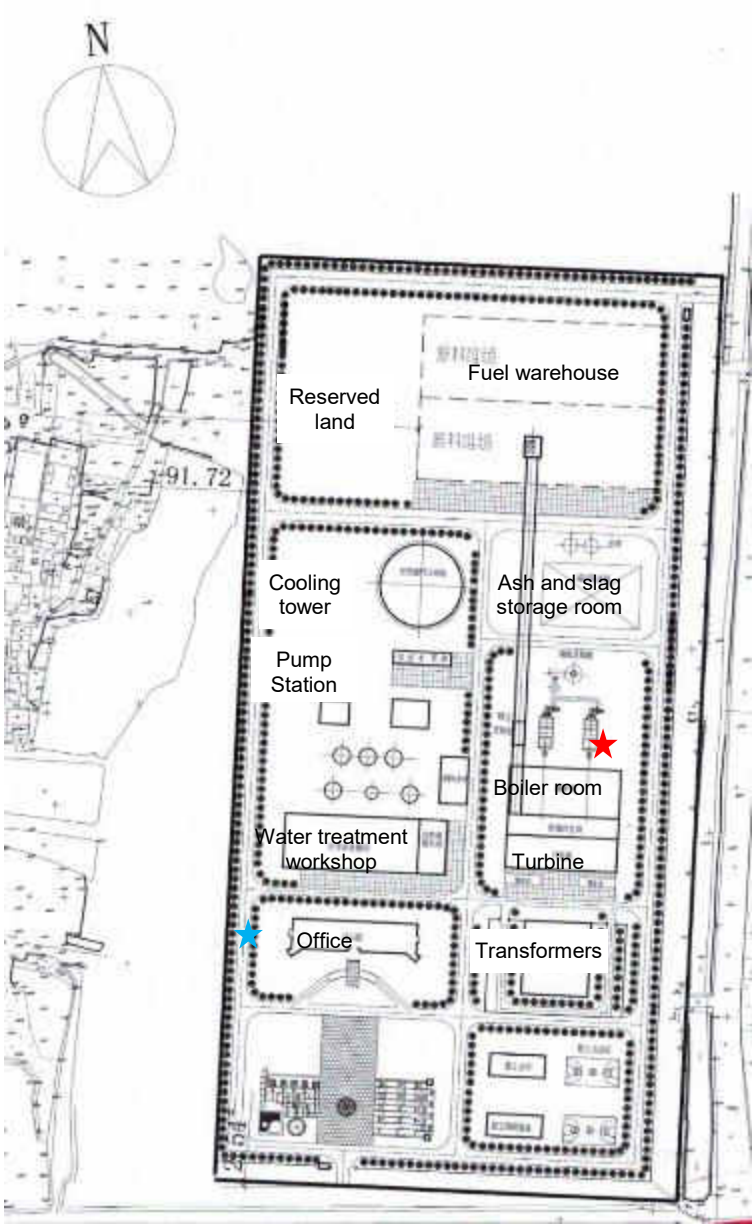
1. Biomass CHP plant

113. The location of biomass CHP plant is presented in **Figure III-2**. Floor area of the plant is 139,838 m^2. Layout of the plant is presented in **Figure III-7**.

114. The component will provide district heating to 1.536 million m^2 in which, 614,400 m^2 is for residential area and 921,600 m^2 is for industrial park. The heat load of the component is presented in **Table III-3**.

115. Maximum heat of the component is 69.43 MW and total heat capacity of the component is presented in **Table III-4**.

Figure III-8: Biomass CHP Layout



Note: ★ is producing well, ★ is disposal well.

Table III-3: Heat load

No.	Heating area (m^2)		Heating load index (W/m^2)	Heat load (MW)
1	Residential area	614,400	38	23.35
2	Industrial area	921,600	50	46.08
3	Maximum heat load			69.43
No.	**Heating area (m^2)**			**Heating load index (W/m^2)**
4	Minimum heat load			38.73
5	Average heat load			49.57

Source: FSR report, 2018.

Table III-4: Heat supply capacity

No.	Parameter	Number
1	Supply water temperature	62°C
2	Return water temperature	50°C
3	Water flow in secondary pipeline network	4,953 t/h
4	Heat supply capacity	74.25 MW

Source: FSR report, 2018.

116. From **Table III-3** and **Table III-4**, we can see that heat supply capacity can meet the maximum heat load of the district heating area.

117. To demonstrate deep geothermal district heating system in Jinan, the proposed component will build two geothermal wells (one producing well and one disposal well) with a heat supply capacity of 1.2 MW to provide district heating to the biomass CHP plant. The heating area of the plant is listed in **Table III-5**.

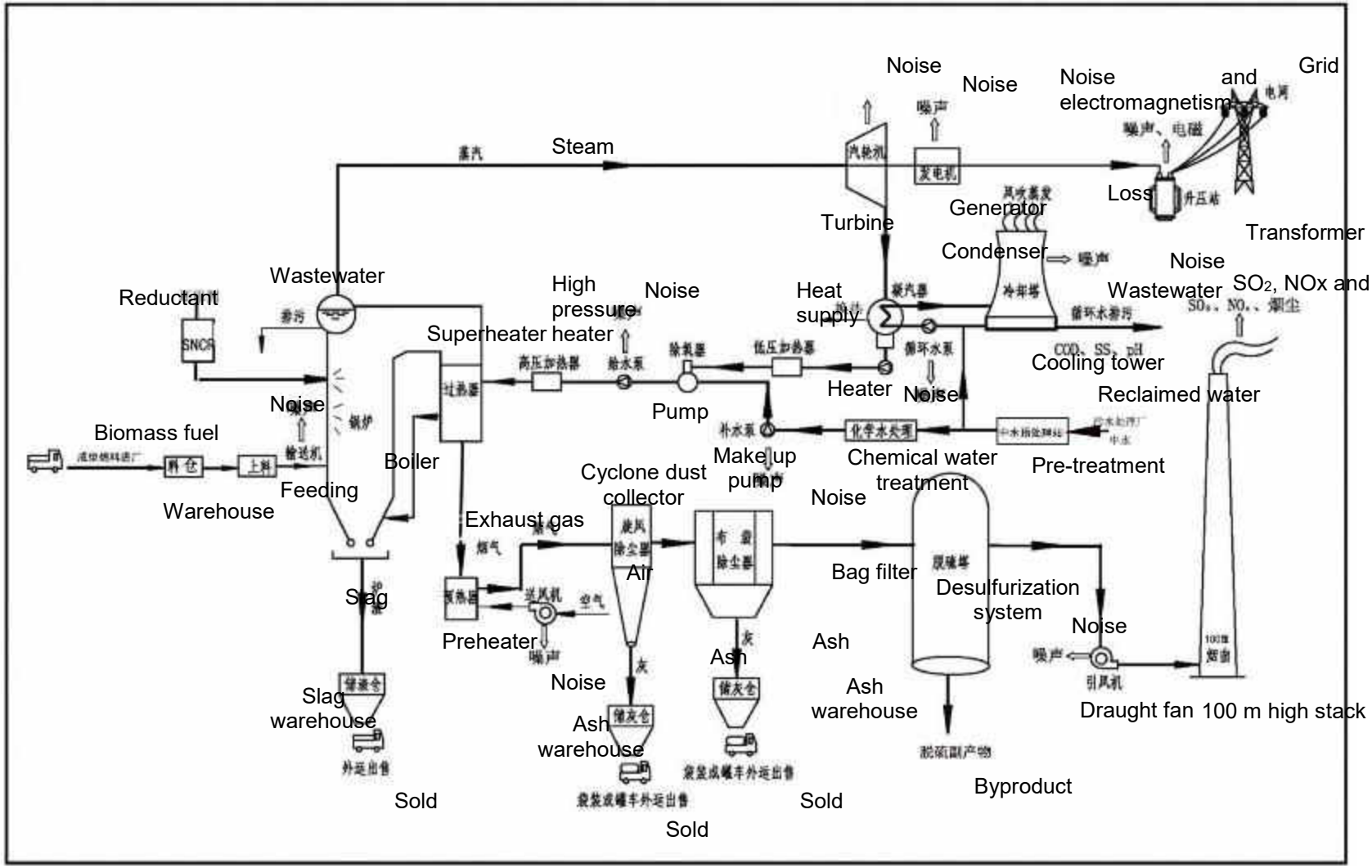
Table III-5: Heat area of Biomass CHP Plant

No.	Parameter	Building area (m^2)
1	Main workshop	11,314.4
2	Control center	4,460.1
3	Dormitory	4,560.4
4	Canteen	2,593.6
5	Service hall	16,43.2
	Total	24,571.7

Source: FSR report, 2018.

118. The process of the biomass CHP plant is presented in **Figure III-8**.

Figure III-9: Process and waste generation map

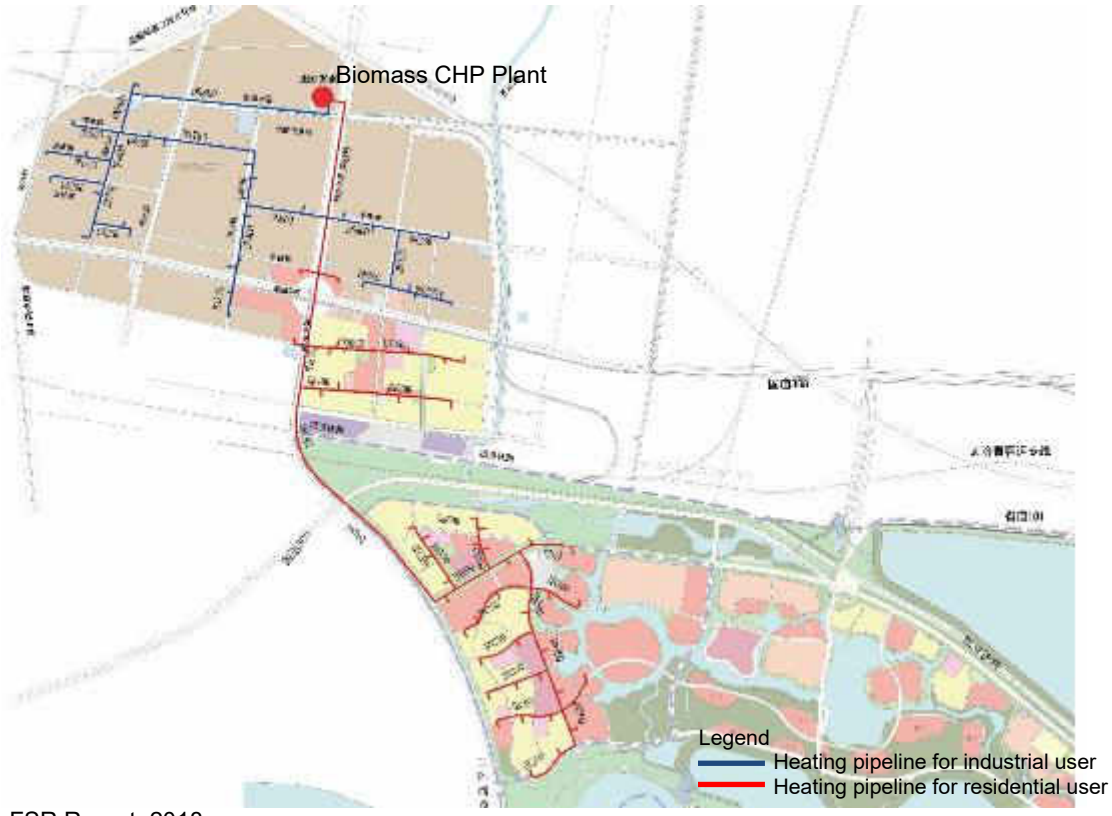


2. Pipeline network

119. All the pipeline of the component will be laid underground within the existing road right of ways.

120. District heating pipeline network is presented in **Figure III-9**. Detailed pipeline network information is presented in **Table III-6** and **Table III-7**.

Figure III-10: District Heating Pipeline Network



Source: FSR Report, 2018.

Table III-6: Pipeline network information for Different Diameters

No.	Description
1	2.4 km heating pipelines (DN 1000) from Power Plant to G308
2	2.35 km heating pipelines (DN 900) from Danji Railway to G309
3	1.1 km pipelines (DN 800) from Zhidong Road to Hongxing Road
4	559 m pipelines (DN 800) from Huafeng Road to Huatai Road
5	665 m pipelines (DN400) from Huasheng Road to G308,
6	508 m pipelines (DN 300) at south of G308

No.	Description
7	797 m (DN 600) from Yuxing Road to Dexing Road,
8	700 m (DN 200) from Dexing Road to Shunxing Road,
9	508 m (DN400) at north of Huatai Road
10	965 m (DN 450) from Huatai Road to Huasheng Road
11	685 m (DN 450) at south of Huasheng Road
12	388m (DN 300) from Dexing Road to Yuxing Road
13	1.33 km (DN 500) at east of Zhidong Road
14	8 km (DN 1000) from Zhidong Road to North Jiluo Road
15	7.6 km (DN 800) from North Jiluo Road to Beijing-Shanghai High Speed Railway

Source: FSR Report, 2018.

Table III-7: Pipeline Information Statistics data

No.	Pipe diameter (millimeter)	Length of pipelines (m)
1	DN200	1,398.20
2	DN300	1,791.40
3	DN400	3,716.60
4	DN450	1,929.20
5	DN500	2,661.00
6	DN600	1,594.60
7	DN800	18,518.00
8	DN900	4,700.00
9	DN1000	20,800.00
	Total	57,109.00

Source: FSR Report, 2018.

121. One DN250 reclaimed water pipeline with a length of 1.2 km will be built. This pipeline is presented in **Figure III-10**.

Figure III-11: Reclaimed Water Pipeline

3. Biomass supply

122. The biomass CHP plant will utilize biomass briquette as fuel. Biomass briquette is made from wheat straw, corn straw, cotton straw and waste barks and branches from bushes and trees for city greening and orchard garden. Based on domestic FSR, the available biomass resource in a radius of 30 km of proposed biomass CHP plant is presented in **Table III-8** and **Table III-10** and the nearby biomass CHP plants are presented in **Table III-9**.

Table III-8: Biomass resource in nearby towns Unit: thousand tons

No.	Plant Area (thousand Mu)	Biomass generated	Available biomass for collection	Available biomass for production
Wheat straw	634.0	351.2	281.0	98.3
Corn straw	569.5	257.8	206.2	72.2
Cotton straw	60.6	17.1	13.7	4.8
Waste barks and branches from bushes and trees for city greening and orchard garden	350.0	350.0	280.0	98.0
Total	NA	1010.7	808.6	273.3

* 1 Mu=667 m^2;
* Available biomass for collection= 0.8*biomass generated, available biomass for productions=0.35* available biomass for collection;
* Based on domestic EIA, there are 50 timber processing plants and 34,600 tons waste will be generated by these plants annually.

Table III-9: Nearby Biomass CHP plants

No.	Project name	Fuel type	Capacity	Location	Distance to the component (km)	Biomass collection radius (km)
1	Guoneng Gaotang Biomass CHP Plant	Straw	30 MW	Liaocheng Gaotang economic and technological development zone	68	30
2	Jinan Shengquan Biomass CHP Plant	corn cob residue and furfural residue	6 MW	Diao Town, Zhangqiu District, Jinan City	52	Different fuel type
3	Jinan Weiquan Biomass CHP Plant	Straw	30 MW	Pingyin County, Jinan City	72	30

123. It can be seen from **Table III-8** and **Table III-9** that the annual biomass resource within a radius of 30 km of proposed biomass CHP plant is 273,300 tons which can meet the estimated annual biomass consumption (155,500 tons) of the component.

124. Available biomass resources in these towns are presented in **Table III-10**.

Table III-10: Biomass resources in nearby towns

No.	Wheat		Corn		Cotton	
	Plant Area (Mu)	Biomass production 10^3 tons	Plant Area (Mu)	Biomass production 10^3 tons	Plant Area (Mu)	Biomass production 10^3 tons
Zhonggong Town	41500	25.7	31000	14.1	364	0.1
Daqiao Town	64800	35.9	46870	20.1	3850	1.6
Sangzidian Town	44500	24.3	31400	13.6	2780	1.1
Sungeng Town	57720	32	54236	24.9	7419	2
Taiping Town	65490	35.8	61537	28.1	8418	2.2
Duoshi Town	81030	44.6	76140	33.0	10415	2.8
Huihe Town	47730	26.3	44850	20.7	6135	1.6
Qudi Town	86580	47.5	81355	37.9	11128	3

No.	Wheat		Corn		Cotton	
	Plant Area (Mu)	Biomass production 10^3 tons	Plant Area (Mu)	Biomass production 10^3 tons	Plant Area (Mu)	Biomass production 10^3 tons
Cuizhai Town	66610	36.6	62580	29	8560	2.3
Pingan Street	33197	18.2	33822	15.5	661	0.2
Yuqinghu Street	23776	12.9	24224	11.1	474	0.1
Guyunhu Street	21084	11.4	21481	9.8	420	0.12
Total	**634017**	**351.2**	**569495**	**257.8**	**60624**	**17.12**

Source: FSR and domestic EIA Report, 2018.

125. There are already several biomass briquettes production plants near the sites. The information is presented in **Table III-11** and the location of the plants is presented in **Figure III-11**. JTPC will buy biomass briquettes from these existing plants. Now JTPC has already signed biomass fuel supply agreements with Company 1, 2 and 3 in **Table III-11** (**Figure III-12**). Total annual capacities of the three companies are 276,000 tons.

Figure III-12: Locations of nearby biomass briquettes plants

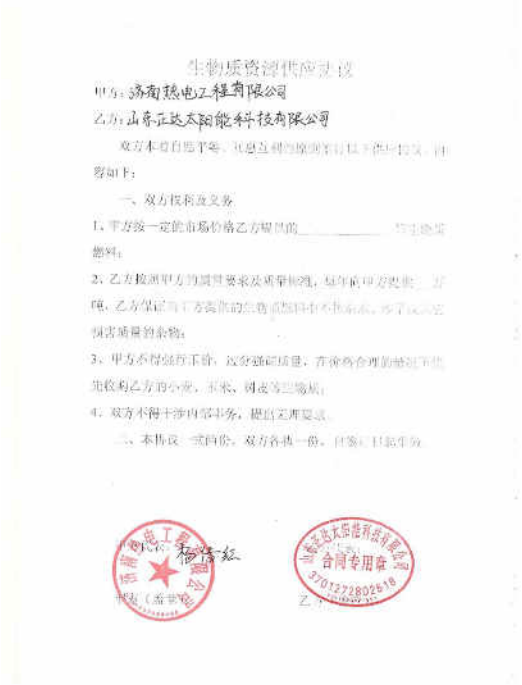
Source: Google earth, 2018.

Table III-11: Nearby biomass briquettes production plants

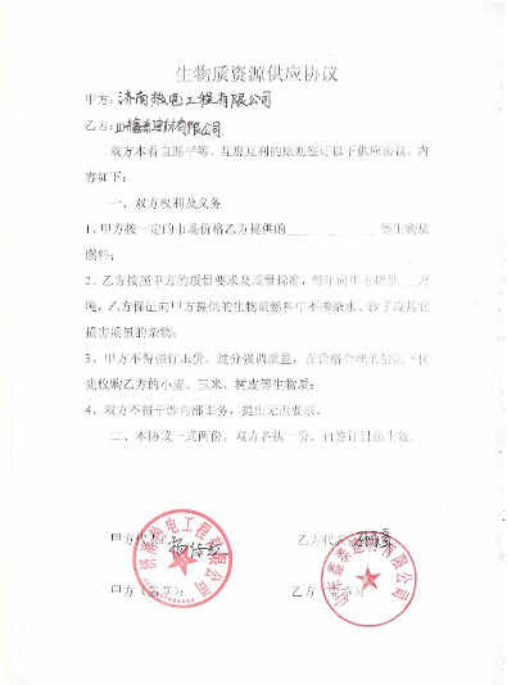
No.	Name	Direction	Distance (km)	Capacity (tons)
1	Shandong Xintai Co., Ltd	East	24	100,000
2	Shandong Zhengda Science and Technology Ltd.	Southeast	37	96,000
3	Shandong Lanchuang New Energy Science and Technology Ltd.	Southeast	23	80,000
4	Yibang Bio-resource (Jinan) Co., Ltd	South	18	7,800
5	Jinan Huasen New Energy Co., Ltd.	Southeast	16	15,000
6	Zhangqiu Tengrui Co., Ltd.	Southeast	50	7,200
7	Jinan Hongjing Co., Ltd.	East	31	2,000

Source: FSR and domestic EIA Report, 2018.

Figure III-13: Biomass supply agreements with biomass briquettes production plants



(i) Agreement with Shandong Xintai Co., Ltd



(ii) Agreement with l Shandong Zhengda Science and Technology Ltd.

(iii) Agreement with Shandong Lanchuang New Energy Science and Technology Ltd.

4. Electrical Design

126. The biomass CHP plant needs a secure electricity supply to meet the demands of electric equipment such as pumps, lighting, control panels, etc. In accordance with national regulations, the central control centers will be equipped with Uninterrupted Power Supplies (UPSs) to ensure the control systems can work continuously. Double 10 kV circuits will be used in the plant. In addition, high voltage and low voltage switch cabinets, direct current (DC) cabinet, and lighting systems have been designed for the plant. Electrical equipment of the component is presented in **Table III-12**.

Table III-12: Electrical equipment

No.	Item	Type
1	35 kV transformer	SF9-25000/110
2	Bus reactor (10 kV)	KK-10-1500-6
3	10 kV power distribution equipment	KYN28-12 centrally installed switchgear
4	380 V power distribution equipment	MNS draw out type switchgear
5	380 V transformer	SCB10-1250/10.5KV

Source: FSR report, 2018.

127. The CHP plant will install two 35 kV transformers at the two generators. The voltage of generated electricity will be increased to 35 KV by transformers, then transferred to 220 kV Ankang substation (**Figure III-13**) which is about 2 km away by transmission line, then finally to the electric grid. The transmission line is included in the component will be laid in the existing underground cable trench owned by Shandong Electric Power Group Corporation. The existing cable trench is 2m high and 2.5m width and is buried beneath Xinyuan Road (**Figure III-14**). The route of the cable trench is presented in **Figure III-15**.

Figure III-14: Ankang 220 kV substation

Figure III-15: Existing cable trench under Xinyuan Road

Figure III-16: Route of existing cable trench

Source: Google earth, 2018.

5. Water supply and wastewater treatment

128. The component will utilize municipal water for domestic water. The component will have 80 staff and daily domestic water consumption is 8 tons and annual is 2400 tons (300 working days). There is one water supply plant in JNMIP with a capacity of 110,000 tons per day. The

total municipal water consumption is very limited compared to JNMIP's water supply capacity. This is not expected to result in any significant negative impact on JNMIP's water supply. A water supply agreement will be signed before the operation of the biomass CHP plant.

129. The component will utilize reclaimed water from the WWTP of JNMIP for production water. The designed reclaimed water consumption during non-heating season is 151 m^3/h, while during heating season is 100.4 m^3/h. One 1.2km length DN 300 reclaimed water pipeline will be built between the WWTP of JNMIP to biomass CHP which is not financed by ADB loan. Reclaimed water of WWTP of JNMIP is required to meet Class IA of *Discharge Standard of Pollutants for Municipal Wastewater Treatment Plants* (GB 18918-2002). And the water quality for reclaimed water used as production water is required to meet Water Quality Standard for industrial use of reclaimed water (GB 19923-2005). The two standards are presented in **Table III-13**.

Table III-13: PRC GB 18918-2002 and GB 19923-2005

No.	Pollutant	Class IA of GB 18918-2002	GB 19923-2005
1	pH	6-9	6.5-8.5
2	SS	10	30
3	COD	50	60
4	Ammonia nitrogen	5	10
5	Total nitrogen	15	NA
6	Chromacity	30	30
7	BOD	10	10
8	Total phosphorus	0.5	1
9	Total hardness	NA	450
10	Turbidity	NA	5
11	TDS	NA	1,000

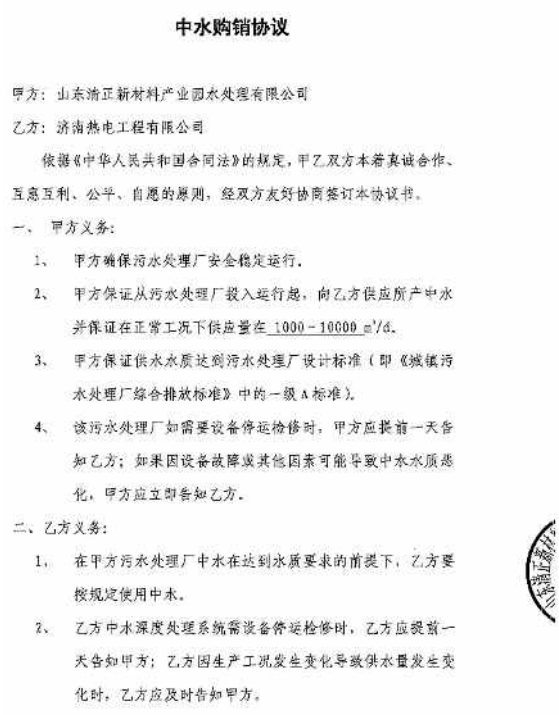
130. Class IA of GB 18918-2002 is not consistent with GB 19923-2005 because Class IA of

GB 18918-2002 does not have the requirements on total hardness, turbidity and TDS, which are important parameters in GB 19923-2005. Therefore, a reclaimed water pre-treatment workshop will be built in the CHP plant. Pre-treatment process is a physical process which is flocculent precipitate+ sand filter + ultra-filtration to reduce SS, macromolecular organic matter and inorganic salt. Treatment capacity is 200 m^3/h.

131. Pretreated water will be treated in chemical water treatment workshop. The process is multi-media filter + ultra-filtration + two stage reverse osmosis + electro deionization. Treatment capacity is 160 m^3/h.

132. WWTP of JNMIP started operation from 2015. Now the wastewater treatment capacity is 30,000 tons per day and reclaimed water production is 9,000 m^3 per day which can meet the reclaimed water consumption of the biomass CHP. IA has already signed reclaimed water supply agreement with JNMIP WWTP (**Figure III-16**).

Figure III-17: Reclaimed water supply agreement



中水购销协议

甲方：山东清正新材料产业园水处理有限公司

乙方：济南热电工程有限公司

依据《中华人民共和国合同法》的规定，甲乙双方本着真诚合作、互惠互利、公平、自愿的原则，经双方友好协商签订本协议书。

一、 甲方义务：

1、 甲方确保污水处理厂安全稳定运行。

2、 甲方保证从污水处理厂投入运行起，向乙方供应所产中水并保证在正常工况下供应量在 1000－10000 m³/d。

3、 甲方保证供水水质达到污水处理厂设计标准（即《城镇污水处理厂综合排放标准》中的一级A标准）。

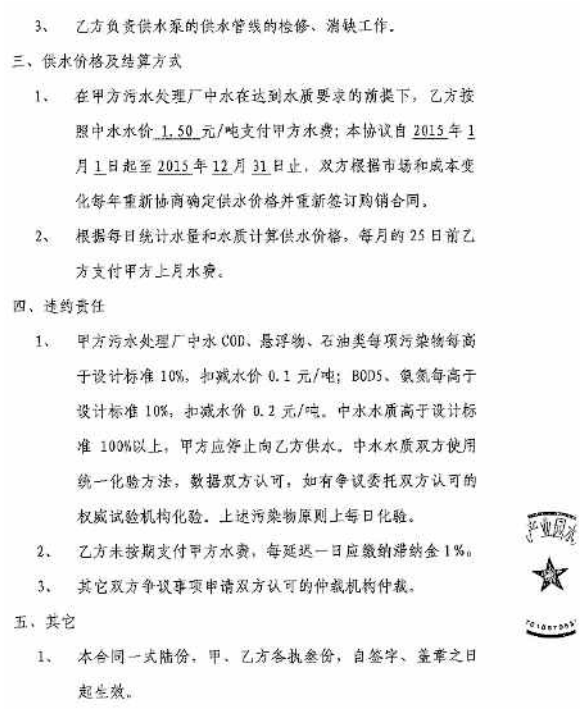
4、 该污水处理厂如需要设备停运检修时，甲方应提前一天告知乙方；如果因设备故障或其他因素可能导致中水水质恶化，甲方应立即告知乙方。

二、乙方义务：

1、 在甲方污水处理厂中水在达到水质要求的前提下，乙方要按规定使用中水。

2、 乙方中水深度处理系统需设备停运检修时，乙方应提前一天告知甲方；乙方因生产工况发生变化导致供水量发生变化时，乙方应及时告知甲方。

Page 1



3、 乙方负责供水泵的供水管线的检修、消缺工作。

三、供水价格及结算方式

1、 在甲方污水处理厂中水在达到水质要求的前提下，乙方按照中水水价 1.50 元/吨支付甲方水费；本协议自 2015 年 1 月 1 日起至 2015 年 12 月 31 日止，双方根据市场和成本变化每年重新协商确定供水价格并重新签订购销合同。

2、 根据每日统计水量和水质计算供水价格，每月的 25 日前乙方支付甲方上月水费。

四、违约责任

1、 甲方污水处理厂中水 COD、悬浮物、石油类每项污染物每高于设计标准 10%，扣减水价 0.1 元/吨；BOD5、氨氮每高于设计标准 10%，扣减水价 0.2 元/吨。中水水质高于设计标准 100%以上，甲方应停止向乙方供水。中水水质双方使用统一化验方法，数据双方认可，如有争议委托双方认可的权威试验机构化验。上述污染物原则上每日化验。

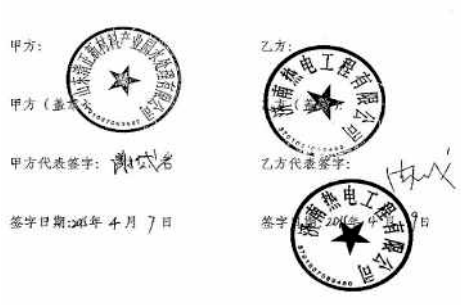
2、 乙方未按期支付甲方水费，每延迟一日应缴纳滞纳金 1%。

3、 其它双方争议事项申请双方认可的仲裁机构仲裁。

五、其它

1、 本合同一式陆份，甲、乙方各执叁份，自签字、盖章之日起生效。

Page 2



Page 3

133. The component will generate both domestic and production wastewater. Production wastewater includes wastewater from chemical water treatment workshop, circulation cooling water system and boiler blow down.

134. Concentrated water from chemical water treatment workshop and boiler blow down will be discharged to the municipal sewerage system. A wastewater treatment agreement will be signed before the operation of the biomass CHP plant.

135. 25% of the water in the chemical water treatment process will be concentrated water from the treated reclaimed wastewater, and 75% will be clean water which will be used as make up water of the boilers. This means pollutants like COD, BOD, ammonia nitrogen, total nitrogen and total phosphorus in concentrated water will be 4 times of the treated reclaimed wastewater. Based on mass balance, the water quality of concentrated water is presented in **Table III-14** which can meet Class B maximum acceptable concentrations (MACs) in Wastewater Quality Standards for Discharge to Municipal Sewers (GB/T 31962-2015).

136. The chemical water treatment process is multi-media filter + ultra-filtration + two stage reverse osmosis + electro deionization. After the treatment process, make-up water of boiler will be very clean with very limited pollutants. The main pollutants in the make-up water will be TDS and conductivity, and COD, BOD, ammonia nitrogen, total nitrogen, SS and total phosphorus will be near 0. Although 10% of make-up water will blow down, which means the pollutants in the blow down will be 10 times of the make-up water, the blow down of boiler can meet Class B maximum acceptable concentrations (MACs) in Wastewater Quality Standards for Discharge to Municipal Sewers (GB/T 31962-2015).

Table III-14: Water quality of concentrated water

No.	Pollutant	Treated reclaimed wastewater in chemical water treatment process	Concentrated water
1	COD	50	200
2	Ammonia nitrogen	5	20
3	Total nitrogen	15	60
4	BOD	10	40
5	Total phosphorus	0.5	2

137. Because drainage from circulation system is clean, part of the drainage will be recycled for dust control in workshops and the rest will be discharged to the municipal sewerage system.

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

139. Wastewater from desulfurization system will be pre-treated by aerated oxidation, and then alkali will be used to adjust pH of wastewater to make the metal precipitate. After the pH adjustment, organic sulfur and flocculant agent will be added to make magnesium sulfite precipitate. Treated wastewater will be discharged to the municipal sewerage system.

140. Because of the high operation temperature of denitration system, no wastewater will be discharged by denitration system.

141. 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.

142. For deep well geothermal wells, wastewater will be generated during operation will be from filter back wash and will be discharged to the municipal sewerage system.

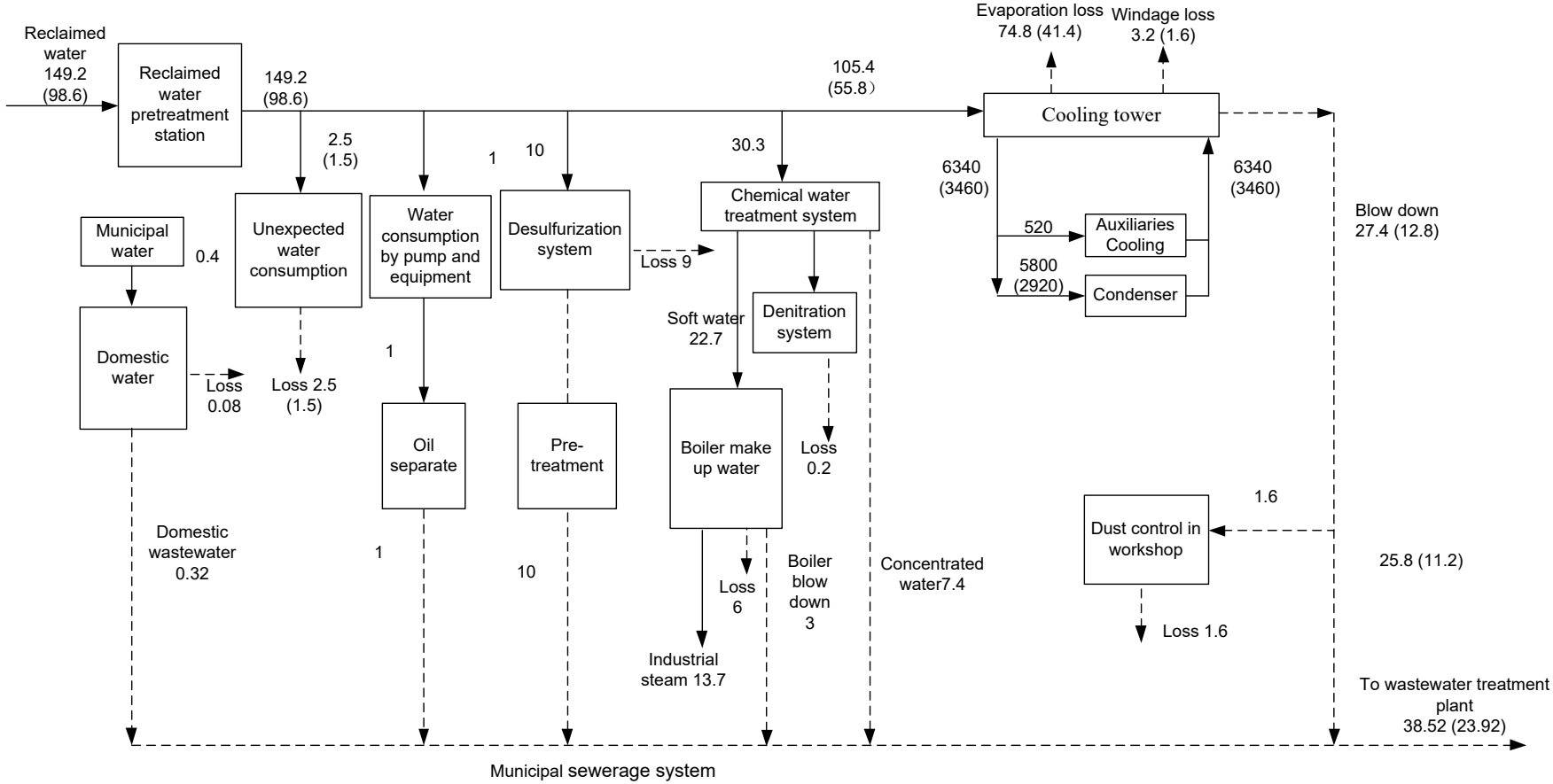
143. Wastewater discharged to the municipal sewerage system will be treated at the WWTP of JNMIP, located at southwest of biomass CHP. All emission concentration of SS, COD, BOD_5 and ammonia nitrogen will be in compliance with of *Wastewater Quality Standards for Discharge to Municipal Sewers* (GB/T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

144. The make-up water data is presented in **Table III-15**. The water balance is presented in **Figure III-17**. Wastewater discharged by the component will be 38.52 m^3/h in non-heating season and 23.92 m^3/h in heating season. All wastewater will be treated by WWPT of JNMIP. Effluent of the WWTP is required to meet Class 1A of *Discharge Standard of Pollutants for Municipal Wastewater Treatment Plants* (GB 18918-2002) then discharged to Tuhai River by pipeline.

Table III-15: Make up Water data Unit: m^3/h

No.	Item	Water Demand		Recycled water		Actual water consumption		Note
		Non-heating season	Heating season	Non-heating season	Heating season	Non-heating season	Heating season	
1	Evaporation loss of cooling tower	74.8	41.4	0	0	74.8	41.4	Source is reclaimed water.
2	Windage loss of cooling tower	3.2	1.6	0	0	3.2	1.6	Source is reclaimed water.
3	Drainage loss of cooling tower	27.4	12.8	1.6	1.6	25.8	11.2	Source is reclaimed water. Water discharge quantity is 25.8 m^3/h in non-heating season (11.2 m^3/h in heating season). 1.6 m^3/h of drainage water is recycled.
4	Chemical water treatment	30.3	30.3	0	0	30.3	30.3	Source is reclaimed water. Discharged concentrated water is 7.4 m^3/h, while 22.7 m^3/h of treated water is sent to boilers and 0.2 m^3/h of treated water is send to denitration system.
5	Domestic water	0.4	0.4	0	0	0.4	0.4	Source is municipal water. 0.32 m^3/h is discharged and 0.08 m^3/h is lost.
6	Water used by pump and equipment	1	1	0	0	1.0	1.0	Source is reclaimed water. All are discharged.
7	Dust control	1.6	1.6	0	0	1.6	1.6	Source is drainage water of cooling tower. All are lost.
8	Denitration system	0.2	0.2	0	0	0.2	0.2	Source is softened water. All are lost
9	Desulfurization system	10	10	0	0	10	10	Source is reclaimed water. 9 m^3/h is lost and 1 m^3/h is discharged.
10	Unexpected water consumption	2.5	1.5	0	0	2.5	1.5	Source is reclaimed water. 2.5 m^3/h is lost in non-heating season and 1.5 m^3/h in heating season is lost.
	Total	151	100.4	1.6	1.6	149.2	98.6	Reclaimed water
		0.4	0.4	0	0	0.4	0.4	Domestic water

Figure III-18: Water Balance of CHP Plant



Note: 1. Numbers in brackets are for heating season;

2. Dotted line is for water emission and loss; full line is for water supply

.

6. Fuel information

145. Estimated annual fuel consumption is presented in **Table III-16** based on different harvest season. Analysis data of different fuel is presented in **Table III-17**.

Table III-16: Estimated annual fuel consumption

Item	Wheat straw	Corn straw	Cotton straw	Waste bark and branch	Average
Hourly consumption (tons/h)	33.06	29.8	32.2	30.78	31.1
Percentage	30	41	2	27	NA
Annual consumption (thousand tons)	49.6	61.1	3.2	41.6	155

Table III-17: Analysis data of different fuel

Item	Wheat straw	Corn straw	Cotton straw	Waste bark and branch	Actual fuel
Ash content as received basis, %	8.03	6.41	3.09	3.59	6.07
Total moisture, %	6.06	4.00	10.3	10.9	6.61
Carbon content as received basis, %	42.38	42.09	44.89	41.91	42.18
Hydrogen content as received basis, %	5.00	4.99	4.64	5.2	5.04
Oxygen content as received basis, %	37.46	38.35	35.24	33.93	36.83
Nitrogen content as received basis, %	0.92	1.03	0.46	2.25	1.32
Sulfur content as received basis, %	0.15	0.13	0.11	0.12	0.13[11]
Higher heating value as received basis, MJ/kg	16.32	16.85	16.54	17.81	16.94
Lower heating value as received basis , MJ/kg	14.95	15.43	15.23	16.55	15.58

[11] Meet the requirement of 0.5% or less sulfur content in the World Bank EHS Guidelines

7. Pollutants generation

146. The pollutants generated are calculated below:

Exhaust gas generation: $V^o = 0.0889C_{ar} + 0.265H_{ar} + 0.0333S_{ar} - 0.0333O_{ar}$ in which: Car is C content as received basis, Har is H content as received basis, Sar is S content as received basis and Oar is O content as received basis.

PM generation =Fuel consumption•[Aar+q_4•Qnet.ar/(8100×4.1816)]•0.9, in which: Aar is ash content as received basis, q_4 is heat loss of boiler (2.5%) and Qnet.ar is lower heating value as received basis.

PM emission= PM generation • (1-η), in which η is dust removal efficiency,

SO_2 generation: SO_2 = 2 • Fuel consumption •(1-q_4)•St.ar•K, in which: q_4 is heat loss of boiler (2.5%), St.ar is S content as received basis and K is SO_2 conversion coefficient (0.85).

SO_2 emission = SO_2 generation •(1-η_{SO2}), in which η_{SO2} is SO_2 removal efficiency.

147. Based on the technical specification of flue gas selective non-catalytic reduction denitration for thermal power plant (HJ563-2010), NH_3 concentration in the exhaust gas must be below 8 mg/m^3.

148. For NOx concentration in exhaust gas, information from similar projects are presented in **Table III-18**. Therefore, the conservatively estimated NOx concentration in the exhaust gas from the biomass CFB boiler will be below 200 mg/m^3.

Table III-18: Exhaust gas emission

Project name	Boiler type	Fuel	Online NOx concentration (mg/m^3)
Kaitai Biomass CHP project	1×75t/h CFB boiler	Cotton straw and branches	44-197
China Energy Conversation Group Biomass Power generation Project in Yantai	2×75t/h CFB boilers	Branches from orchards and straw	10-126
Guodian Biomass Power generation Project in Liaocheng	2×75t/h CFB boilers	Straw	140-170
Biomass Power generation Project of Changqing Environment Protection Company	1×130t/h CFB boiler	Straw	144-154

149. Based on parameter in **Table III-14** and the above formulas, the pollutants generated by the component are presented in **Table III-19**.

Table III-19: Generated pollutants of the component

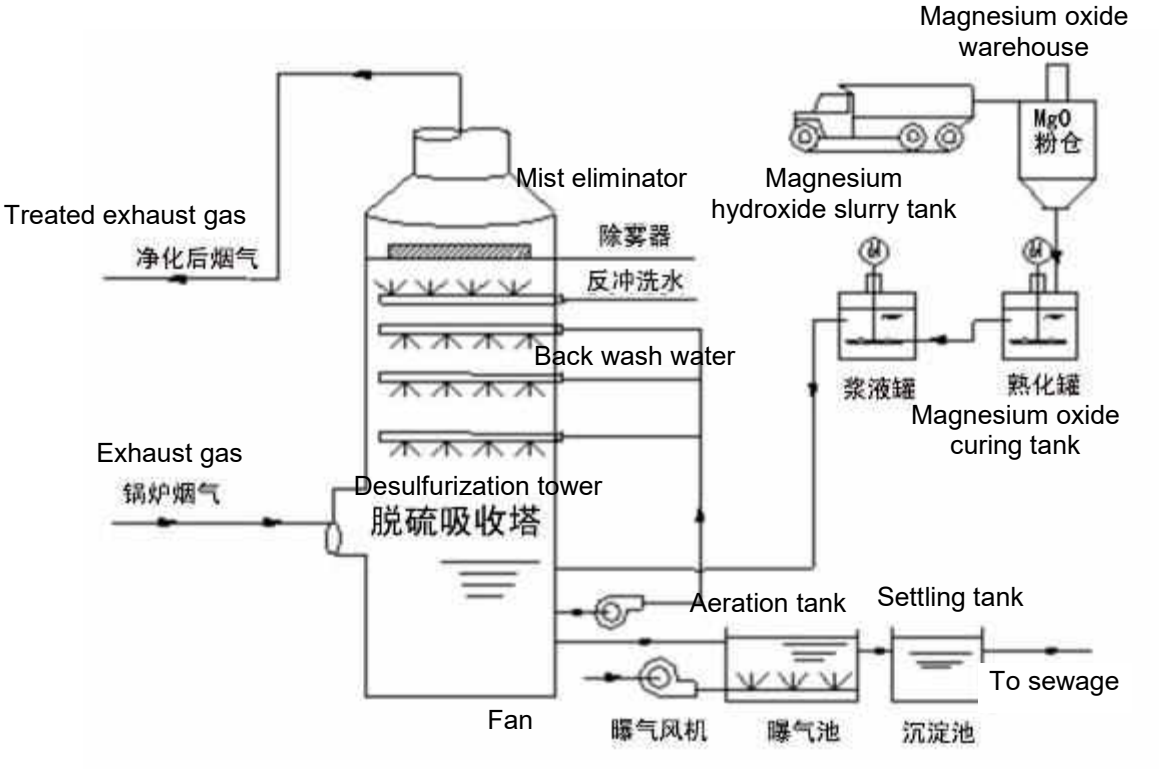
Fuel consumption	Exhaust gas flow (m^3/h)	Pollutants	Concentration (mg/m^3)	Emission rate (kg/h)	Annual pollutants generation (tons)
155,000	166,034.8	PM	13,853	2,300	11,500.40
		SO_2	430	72	356.97
		NOx	200	34	166.03
		NH_3	8	1.32	6.64

150. Annual emission quantity of PM, SO_2, NOx and ammonia generated by the component before the treatment is 11500.40., 356.97, 166.03 and 6.64 tons.

8. Desulfurization system

151. Based on **Table III-19**, the SO_2 concentration in the exhaust gas without desulfurization system will be 430 mg/m^3. Therefore flue-gas desulfurization (FGD) technology will be utilized in the component. The technology will be magnesium oxide wet FGD. The process is presented in **Figure III-18**.

Figure III-19: Desulfurization process



Source: Domestic EIA, 2018.

152. Main reactions occurred during desulfurization process are:

$MgO + H_2O \rightarrow Mg(OH)_2$

$SO_2 + H_2O \rightarrow H_2SO_3$

$H_2SO_3 + Mg(OH)_2 \rightarrow Mg\,SO_3$ (sediment)$+ 2H_2O$

$2MgSO_3 + O_2 \rightarrow 2Mg\,SO_4$ (rare).

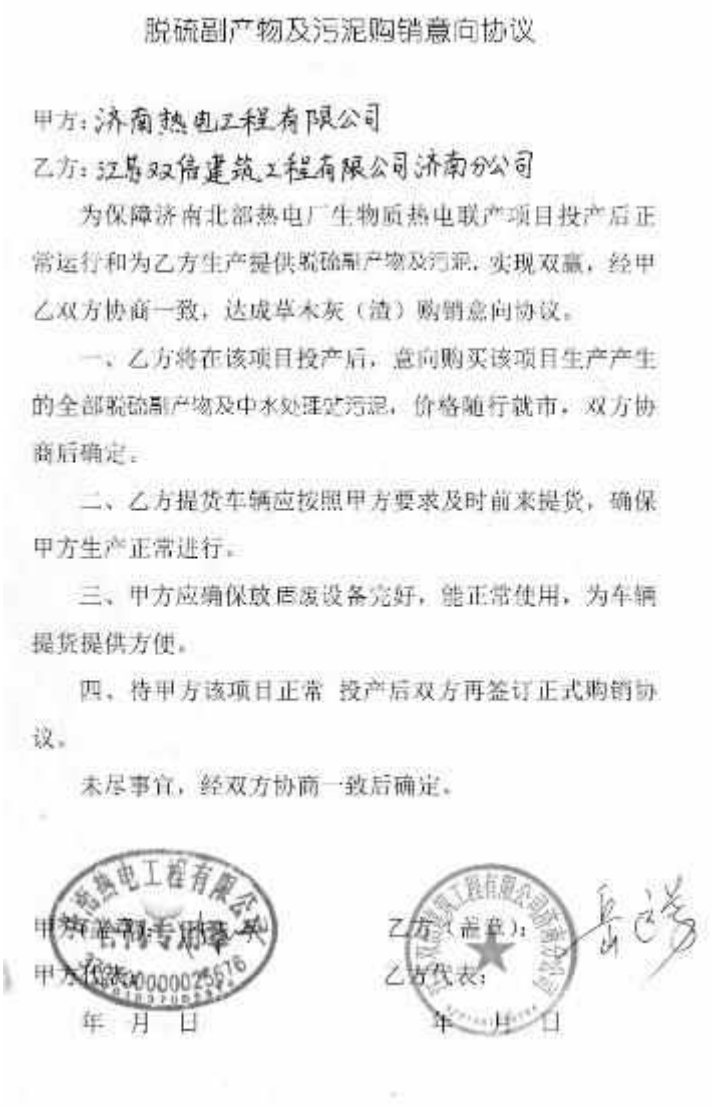
153. Desulfurization tower is a counter flow spray tower. Magnesium hydroxide slurry is pumped into the tower then sprayed at the top through muzzle. The slurry then goes to the tower bottom from top and contacts SO_2 in the exhaust gas and then magnesium sulfite with rare magnesium sulfate generated. Finally, magnesium sulfite goes to the circulation slurry tank at the tower bottom. The slurry will be transferred to dewatering system to generate a desulfurization byproduct with a water content no mora than 20%. Byproduct will be transferred outside to be reused as construction materials.

154. There is a two-stage mist eliminator installed at the top of the desulfurization tower to remove liquid drop. Wastewater from desulfurization system will be discharged to sewage then finally treated in WWTP of JNMIP.

155. Annual magnesium oxide consumption of the component will be 450 tons (5000 hours' operation time) and annual generated byproduct will be 1,200 tons.

156. The IA has already signed a byproduct and sludge (generated from reclaimed water pretreatment) supply and treatment agreement with Jinan subcompany of Shuangxin Construction Engineering Co., Ltd.

Figure III-20: Sludge and Byproduct Supply Agreement



脱硫副产物及污泥购销意向协议

甲方：济南热电工程有限公司

乙方：江苏双信建筑工程有限公司济南分公司

为保障济南北部热电厂生物质热电联产项目投产后正常运行和为乙方生产提供脱硫副产物及污泥，实现双赢，经甲乙双方协商一致，达成草木灰（渣）购销意向协议。

一、乙方将在该项目投产后，意向购买该项目生产产生的全部脱硫副产物及中水处理站污泥，价格随行就市，双方协商后确定。

二、乙方提货车辆应按照甲方要求及时前来提货，确保甲方生产正常进行。

三、甲方应确保放置废设备完好，能正常使用，为车辆提货提供方便。

四、待甲方该项目正常 投产后双方再签订正式购销协议。

未尽事宜，经双方协商一致后确定。

甲方（盖章）：

甲方代表：

年 月 日

乙方（盖章）：

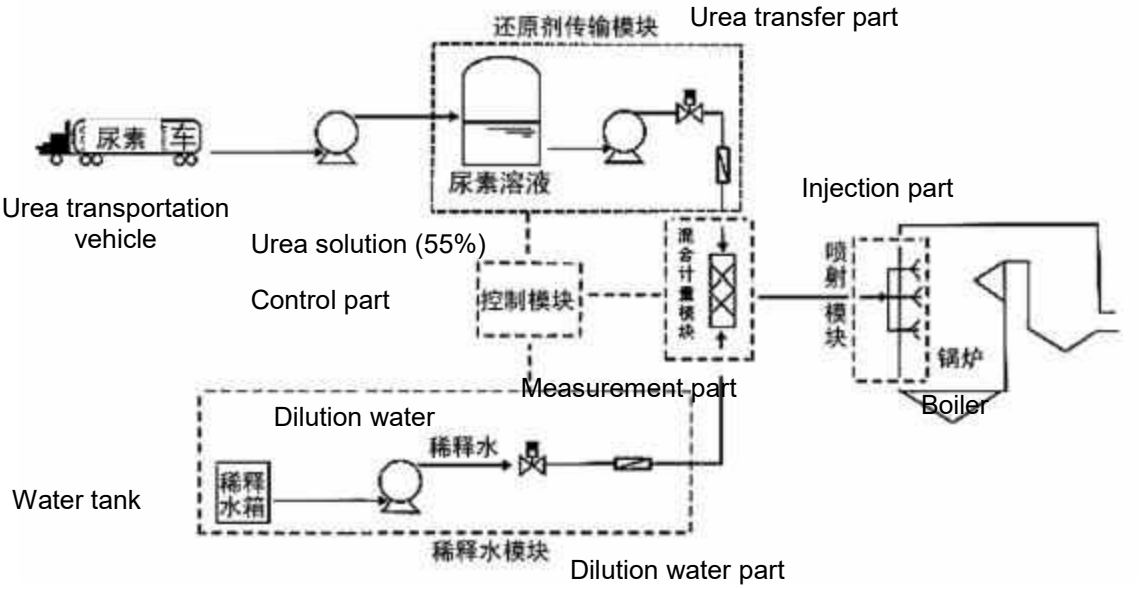
乙方代表：

年 月 日

9. Denitration system

157. Based on information from similar projects, the NOx concentration in the exhaust gas from the biomass CFB boiler will be 200 mg/m^3 which can't meet the Emission Standards of Thermal Power Plants in Shandong Province (DB 37/664—2013). Therefore one denitration system will be installed. Denitration system will utilize SNCR denitrification technology. Denitration agent will be urea. Annual urea consumption will be 120 tons (5000 hours operation time) One 30 m^3 urea warehouse will be built. SNCR denitrification process is presented in **Figure IV-2**.

Figure III-21: SNCR denitrification process



Source: Domestic EIA, 2018.

158. 55% urea solution is heated by primary air, then pyrolytic reaction will occur and urea will be decomposed into ammonia, CO_2 and water vapor. Combined with primary air, ammonia concentration in diluted air will be no more than 5% to control ammonia concentration in exhaust gas below 8 mg/m^3. Then the diluted air is injected into boiler where NOx will be reduced to N_2 by ammonia.

159. SNCR has a strict requirement on reaction temperature. Best temperature range for urea SNCR technology is 800-1000°C. The furnace temperature of CFB boilers is in the range of 850-950°C which is a suitable temperature for urea SNCR technology. Besides, designed retention time of exhaust gas in high temperature zone will be more than two seconds which provide a guarantee for NOx removal ratio. Designed denitration efficiency of the system is 70%.

10. Ash and slag collection system

160. Based on **Table III-15** and the formulas above, the PM concentration in the exhaust gas without desulfurization system will be 13,853 mg/m^3. To meet the PRC emission standard, two stage of ash removal will be installed. Pneumatic ash removal will be utilized in this component. Cyclone dust collector and bag filter will be installed for ash removal with an efficiency of 99.9%. Dry ash collected by dust collector will fall into ash hopper then transferred to dry ash warehouse by 1m^3 fluidizing transporter. A 0.25 m^3 fluidizing transporter will be installed at the flue below preheaters of boilers and ash collected by which will be transferred to ash warehouse too. The dry ash warehouse is 500m^3 and can stored ash from 2 boilers for 10 days.

161. There will be ash emission point at the bottom of the ash warehouse where dry ash can be transferred to closed tank car, then ash will be transported to outside for recycling.

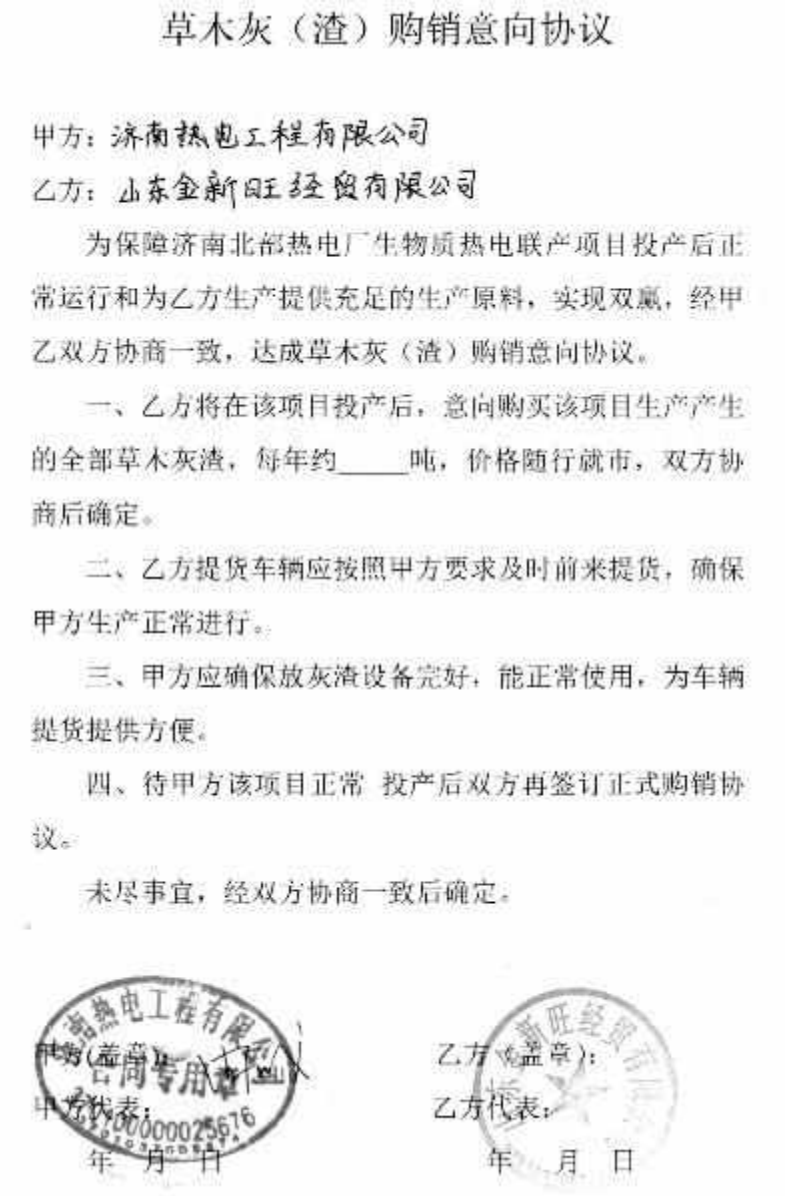
162. Dry slag removal technology will be utilized to remove slag of boilers. Three slag collection pipes (one pipe for emergency) will be installed at the slag emission point. Collected slag will be cooled to 80°C at a slag cooler, then transferred to slag warehouse by bucket slag removal

equipment.

163. The slag warehouse is 1,000m^3 and can stored slag from 2 boilers for 10 days. Discharge valves will be installed at the bottom of slag warehouse to transfer the slag to vehicles.

164. All ash and slag generated will be sold and reused as fertilizer. Besides, one 1,000 m^3 warehouse will be built for temporary storage of ash and slag which can't be transported to outside in time. The IA has already signed one ash and slag supply and treatment agreement with Shandong Jinxinwan Business Co., Ltd.

Figure III-22: Ash and Slag Supply Agreement



草木灰（渣）购销意向协议

甲方：济南热电工程有限公司

乙方：山东金新旺经贸有限公司

为保障济南北部热电厂生物质热电联产项目投产后正常运行和为乙方生产提供充足的生产原料，实现双赢，经甲乙双方协商一致，达成草木灰（渣）购销意向协议。

一、乙方将在该项目投产后，意向购买该项目生产产生的全部草木灰渣，每年约_____吨，价格随行就市，双方协商后确定。

二、乙方提货车辆应按照甲方要求及时前来提货，确保甲方生产正常进行。

三、甲方应确保放灰渣设备完好，能正常使用，为车辆提货提供方便。

四、待甲方该项目正常 投产后双方再签订正式购销协议。

未尽事宜，经双方协商一致后确定。

甲方（盖章）：

甲方代表：

年 月 日

乙方（盖章）：

乙方代表：

年 月 日

11. Exhaust gas, waste and wastewater emission

165. Exhaust gas emission of the component is presented in **Table III-20**. It can be seen from the table that once operational, exhaust gas the component can meet the requirements that once operational, exhaust gas the component can meet the requirements in *Emission Standards of Thermal Power Plants in Shandong Province* (DB 37/664－2013). Annual emission quantity of PM, SO_2, NOx and ammonia before the treatment is 11500., 356.97, 166.03 and 6.64 tons, respectively and 11.5, 35.7, 83.1 and 0.66 tons, respectively after the treatment.

Table III-20: Exhaust gas emission

Fuel consumption	Exhaust gas flow (m^3/h)	Pollutants	Generation before treatment		Emission after treatment		Annual emission quantity (ton)
			Concentration (mg/m^3)	Emission rate (kg/h)	Concentration (mg/m^3)	Emission rate (kg/h)	
155,000	166,034.8	PM	13,853	2,300	13.9	2.3	**11.5**
		SO_2	430	72	43.0	7.14	**35.7**
		NOx	200	34	100	16.62	**83.1**
		NH_3	8	1.32	0.8	0.132	**0.66**

Note: Dust removal efficiency is 99.9%, desulfurization efficiency is 90%, denitration efficiency is 50% and ammonia removal efficiency is 90% NH_3 concentration is escape velocity in PRC standard.

166. Based on domestic EIA and information from similar projects, fugitive dust generation of the fuel warehouse is 0.01% of biomass consumption which is equal to 15.55 tons annually. Biomass fuel will be transferred and transported through closed system and 95% of the fugitive emission will be reduced. Then annual fugitive emission of the fuel warehouse is 0.93 tons.

167. Bag filters will be installed at the top of ash warehouse. Collected dust will be discharged through one 15m high stack (inner diameter of the outlet is 0.4m). Dust emission is presented in **Table III-21**.

Table III-21: Dust emission of dust warehouse

No.	Location	Exhaust gas flow (m^3/h)	Concentration (mg/m^3)	Emission rate (kg/h)	Annual emission quantity (ton)	Standard (mg/m^3)
1	Ash warehouse	10,000	20	0.2	1.25	30

Source: Domestic EIA, 2018.

168. Based on **Table III-20** and **Table III-21**, total annual fugitive emission quantity of the component is 2.18 tons. And the fugitive emission can meet the requirements in Shandong Province's Integrated particulate matter emission standard for stationary sources in Shandong Province (DB 37/1996-2011)

169. Because there will be no biomass fuel production in the biomass CHP plant, the fuel stored

in fuel warehouse has already been dried. The fuel warehouse can only store 10 days fuel which means the fuel will not be stored for more than 10 days. Besides, the fuel warehouse will implement rain-proof and excellent ventilation measures to prevent the fuel be affected with damp. Fuel stored in fuel warehouse will not have chemical reaction to generate odor pollutants like NH_3 and H_2S. Because biomass combustion will not generate NH_3 and H_2S, no NH_3 and H_2S will be generated during fire accident.

170. Based on monitoring data from Jinan Weiquan Biomass CHP Plant (one 130 t/h CFB boiler), NH_3 and H_2S concentration at the site boundaries are presented in **Table III-22** which can meet the requirements in Emission standards for odor pollutants (GB 14554-93).

Table III-22: NH_3 and H_2S concentration at the site boundaries of Jinan Weiquan Biomass CHP Plant

Pollutants	Monitoring time	Direction	Monitoring results	Limit
NH_3	January 20, 2016	North	0.038-0.051	1.5
		South	0.071-0.081	
		West	0.064-0.072	
		East	0.059-0.068	
	January 21, 2016	North	0.037-0.052	
		South	0.046-0.078	
		West	0.075-0.080	
		East	0.053-0.069	
H_2S	January 20, 2016	North	0.001-0.002	0.06
		South	0.001-0.003	
		West	0.001-0.002	
		East	No detection	
	January 21, 2016	North	No detection	
		South	0.002	
		West	0.001-0.003	
		East	0.001-0.002	

171. Parameters of wastewater are presented in **Table III-23**. The concentrations of different pollutants are from Jinan' Weiquan Biomass CHP Plant's operation data. Once operational, annual wastewater discharged by the component will be 150,552m^3 and can meet Class 1A of *Discharge Standard of Pollutants for Municipal Wastewater Treatment Plants* (GB 18918-2002). The wastewater will be treated in WWTP of JNMIP and discharged to Tuhai River by pipeline. A

wastewater treatment agreement will be signed before the operation of the biomass CHP plant. Estimated COD and ammonia nitrogen discharged by the component are 7.88 and 0.79 tons respectively.

172. **Table III-23: Wastewater analysis data**

No.	Item	Flow (m^3/h)	COD (mg/L)	Ammonia nitrogen (mg/L)	Petroleum (mg/L)
1	Boiler blow down	3	30	15	--
2	Wastewater from chemical water treatment workshop	7.6	150	15	--
3	Circulation system blow down	27.4 (12.8)	135	13	--
4	Oily wastewater from pump and equipment	1	200	25	80
5	Wastewater from desulfurization system	1	200	25	--
6	Domestic wastewater	0.32	350	25	20
	Total	40.32 (25.72)	146	15.5	2.6 (4.2)
	Standard	NA	NA	≤500	≤20

Note: NA means not applicable; the numbers in bracket is for heating season. The pollutants concentrations are from similar projects
Source: Domestic EIA, 2018.

173. Based on operation data of Jinan' Weiquan Biomass CHP Plant (one 130 t/h CFB boiler), estimated solid waste generated by the component is presented in **Table III-24**.

Table III-24: Waste generated by the component

No.	Item	Annual quantity (tons)	Data of Jinan Weiquan Biomass CHP Plant
1	Ash	7,755	6,721
2	Slag	5,215	4,520
3	Byproduct from desulfurization system	1,200	1,040
4	Sludge from reclaimed water pre-treatment workshop	0.33	NA
5	Oily waste	0.6	0.5
6	Domestic waste	24.0	18.0

Source: Domestic EIA, 2018.

174. Environmental protection measures of the component are summarized in **Table III-25**.

Table III-25: Environmental protection measures

Category	Item	Measures
Exhaust gas	SO_2	Desulfurization system
	NOx	Denitration system
	PM	Cyclone dust removal and bag filter
	Ammonia	Synergistically removed by desulfurization system
	Pollutants online monitoring	Online continuous emissions monitoring system for SO_2, NOx, PM and ammonia etc.
Wastewater	Wastewater from desulfurization system	Treated then discharged to sewage
	Oily wastewater	Oil separator
	Wastewater from chemical water treatment workshop and boiler blow down	To sewage
	Circulation system blow down	Recycled then discharged to sewage
	Domestic wastewater	To sewage
Solid waste	Ash and slag	Sold to use as fertilizer
	Byproduct from desulfurization system	Sold to make construction materials
	Sludge from reclaimed water pre-treatment workshop	Sold to make construction materials
	Oily waste	Treated by certificated company
	Domestic waste	Collected and treated by local sanitary department

Source: Domestic EIA, 2018.

12. Fire protection

175. The biomass plant especially biomass briquettes warehouse will be in compliance with relevant PRC fire protection regulations and requirements, including the Code for Design of Small Thermal Power Plant (GB50049-2011), Code of Design on Fire Protection of Thermal Power plant and Substation (GB50229-2006), Code for Design of Straw Power Plant (GB 50762-2012) and Regulation on Electric Apparatus Design for Explosion and Fire Risk Environment (GB50058-92). All risk areas especially biomass briquettes warehouse will have alarm systems able generate audible and visual alarms, and automatic fire suppression systems.

176. An emergency risk and response plan will be established in accordance with the “National Environmental Emergency Plan” (24 January 2006), other relevant PRC laws, regulations and standards, World Bank EHS Guidelines and ADB’s SPS 2009. In addition, construction and operation phase EHS plans will be developed by specialists in occupational health and safety and

boilers to ensure protection of workers and the surrounding community. The nearby communities will be informed of the potential risks of fire, explosion, etc. and the emergency drills will be conducted.

13. Heating and Ventilation

177. Facilities will be equipped with cast-iron radiators for space heating. The design room temperature of the complexes, control rooms, and gatehouses is 18°C; pump rooms, heat exchanger rooms, and garages is 10°C; and chemical testing rooms and bathrooms is 16°C. The feed and return water temperatures at HES will be 80 and 65°C respectively.

178. The control room and electric rooms will be mechanically ventilated by fans. Other rooms will be naturally ventilated. Noise levels of control room and electric rooms should be less than 60 dB.

14. Landscaping

179. The CHP Plant sites will be vegetated with appropriately selected native trees and shrubs. The landscape plan is presented in **Table III-26** and budget is presented in **Table III-27**.

Table III-26: Landscape Plan for the CHP Plant Site

No.	Type	Local Species	No.	Location	Total Area (m^2)
1	Arbor	Ligustrun lucidum	200	Road sides	6730
		Magnolia denudata	200	Road sides	
		Dragon juniper	200	Around office building	
2	Bush	Euonymus japonicus	200	Around fuel warehouse	
		Ligustrum quihoui	200	Around fuel warehouse	
3	Hedgerow	Holly	200	Around fuel warehouse and roads	
4	Grass	Trifolium repens	2000 m^2	Around fuel warehouse and roads	
		Lolium perenne	1500 m^2	Around fuel warehouse and roads	

Source: Domestic EIA, 2018.

Table III-27: Landscape plan budget Unit: CNY

No.	Item	Cost
1	Land leveling	10,000
2	Landscape planting	30,000
3	Plant purchase	110,000
4	Water spray pipe and equipment	60,000
5	Daily maintenance cost	100,000
6	Landscape reserve fund	120,000
	Total	430,000

Source: Domestic EIA, 2018.

15. Temporary Worker's Camps

180. During the construction period (from 2018 to 2020), a temporary workers' camp with a capacity of 100 workers will be installed at the plant site within the premise of the biomass CHP plant. Maximum workers on site will be 80. 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. The worker camp will be connected to municipal water system and sewer system. Domestic waste collection bins will be installed at the worker camp to collect domestic waste.

IV. DESCRIPTION OF THE ENVIRONMENT

A. Location

181. The component will be implemented at JNMIP, 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

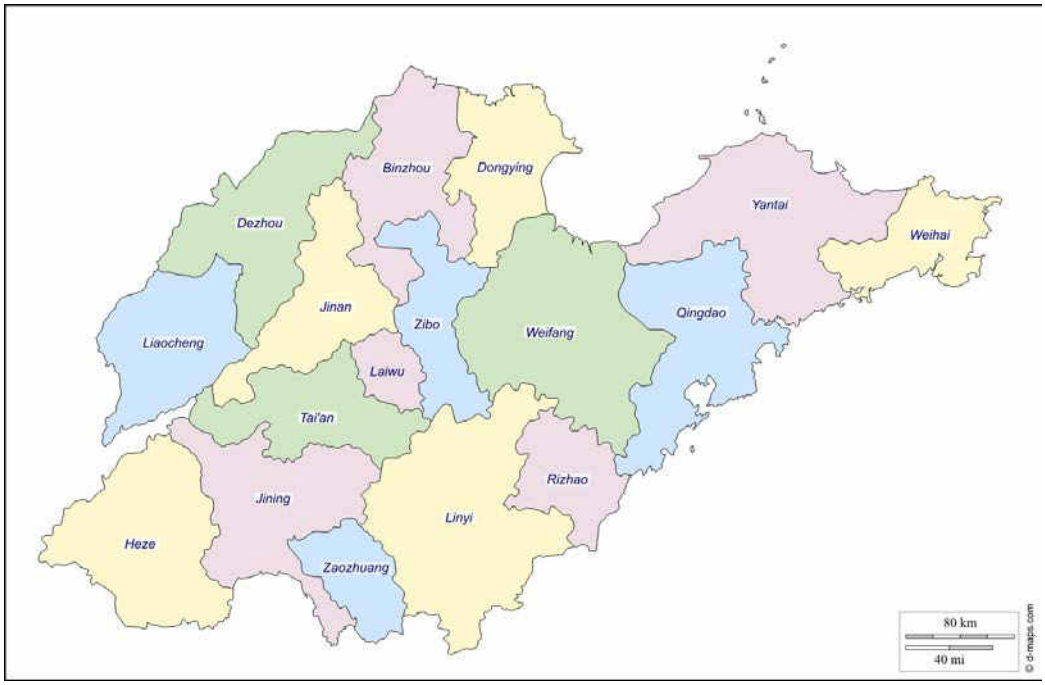
182. Shandong is a coastal province of the PRC and is part of the East China region (**Figure IV-2**). Neighboring provinces are Anhui, Hebei, Henan and Jiangsu.

Figure IV-2: Shandong Province in China

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

183. 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

184. 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.

185. 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 was 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.

186. 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.

187. 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.

188. The province has 30.58 billion m^3 of water resources and 307.4 m^3 per capita in 2016. 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

189. **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**).

190. Based on the geothermal survey report for northern Shanghe county (average of three test wells with depth of over 1300 m), which is about 80 km north of the biomass CHP site, the chemical composition of the geothermal water is as follows:

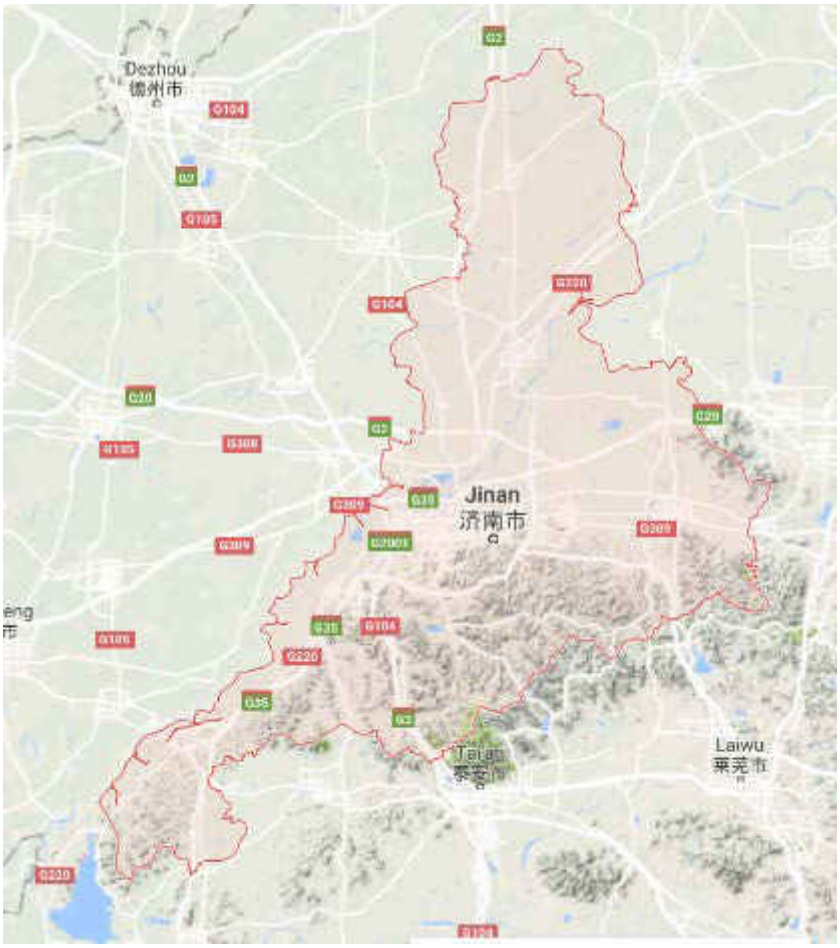
Item	Content (mg/l)	Item	Content (mg/l)
Degree of mineralization	6731.24	Permanent hardness	420.33
pH	7.8	Temporary hardness	185.15
Total hardness	605.48	Total alkalinity	185.15
K+	16.25	Cl-	2708.38
Na+	2225.00	SO42-	1301.61
Ca2+	182.36	HCO3-	255.77
Mg2+	36.45	F-	1.12
NH4+	5.50	NO3-	<0.02
Fe3+	1.30	H2SiO3	40.40
Fe2+	<0.08	Soluble H2SiO3	27.50

191. Main gases in the geothermal water are: CO_2 14.52 mg/l, H_2S 0.46 mg/l. Groundwater testing will be conducted for this component after drilling.

192. Well casing and pipes will be designed to prevent corrosion. Polyethylene of raised temperature resistance pipe will be used, which is a high temperature and corrosion resistance material and will be regularly changed to prevent potential leakage of the pipes. Besides, to prevent potential leakage, sealing equipment such as expanding rubber sealing equipment will be installed to prevent groundwater at different strata to be mixed. An emergency water tank will be prepared for temporary storage of geothermal groundwater in case the injection well is blocked or leak happens due to flocculation or corrosion. Diameter of the geothermal well is around 0.5m

and area of each geothermal well is around 0.2 m^2. The floor area of the geothermal station is 308 m^2 (22 m x 14 m).

Figure IV-4: Jinan topography



Source: Google map, 2018

193. **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.

194. 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.

195. According to the domestic EIA, 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.

196. **Land use.** The component site is in developing urbanized industrial area (JNMIP), and is predominantly in existing road right-of-ways.

197. **Hydrology.** Jinan lies on the south shore of the Yellow River, and it is the main river in the component area. 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. 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.

198. **Hydrogeology.** The ground near the component site is pore phreatic water in loose rock mass. The ground water 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).

199. **Geothermal energy**. Geothermal energy is rich near component site. There are four existing deep geothermal wells near the component site. Based on information from these wells, the depths of the wells are 1,810-1,875 m, temperatures of groundwater are 61-63°C, the flows are 1,300-1,746.08 m^3/d, hydrochemical types are Cl-Na type of Cl.SO4- Na type and salinity is 0.641-0.809 g/L. From the information, it can be concluded that deep geothermal energy near the component site can provide enough heat for the component.

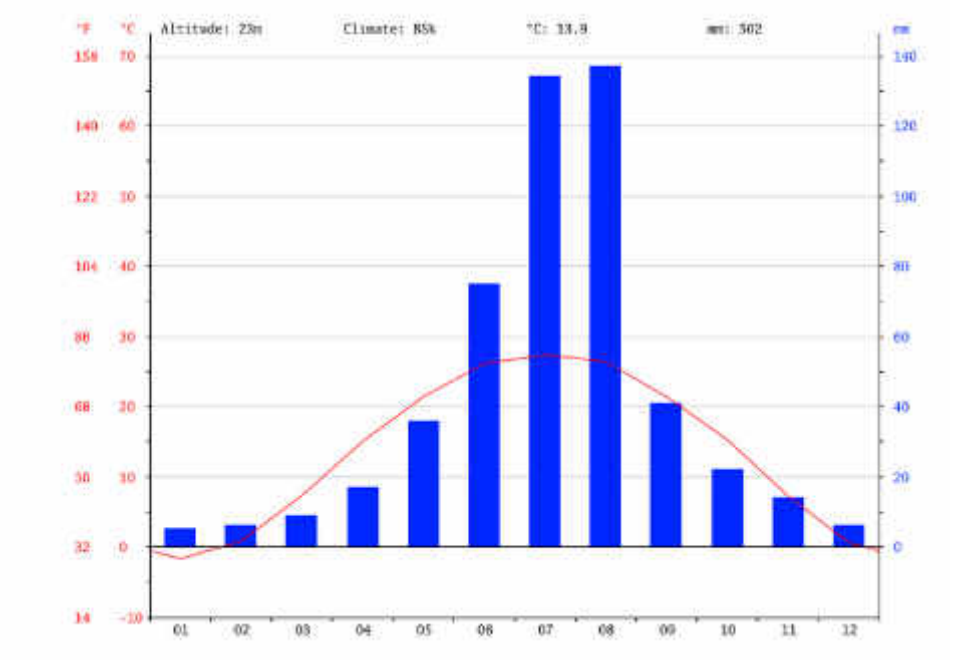
200. **Meteorology and Climate.** Jinan has a temperate continental climate with four distinct seasons. It is dry in the spring, hot and rainy in the summer, cool in the autumn, and dry and cold in the winter. The average annual temperature in Jinan is 16.6°C, the average summer average temperature is 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**).

201. 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**).

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

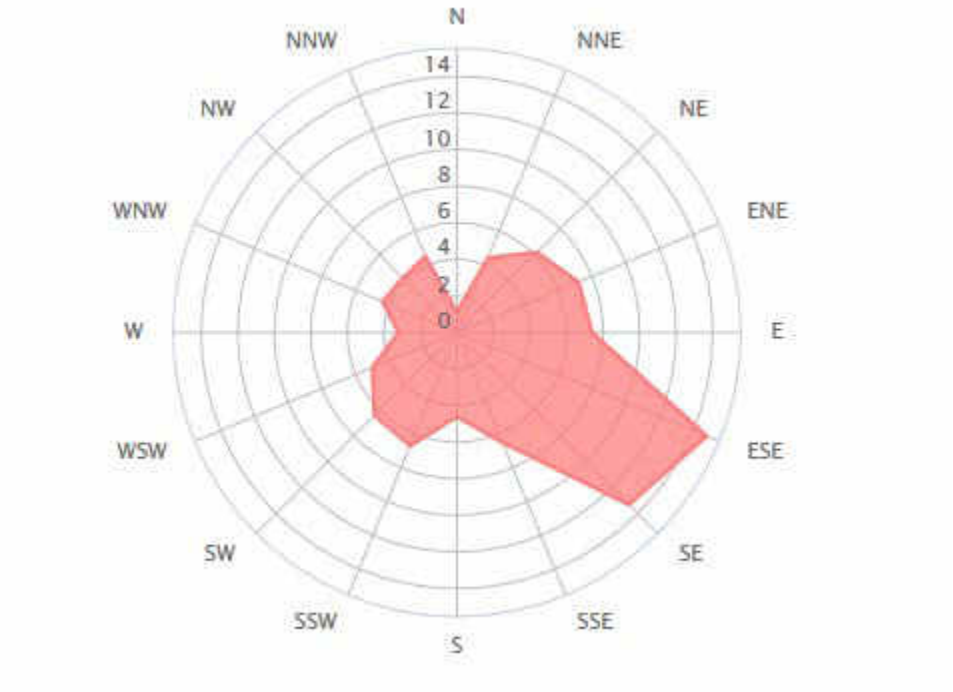
203. **Frost-free Days.** There is an average of 178 frost free days per year. The first frost typically occurs in the first 10 days of October, and the last frost day is typically in the first 10 days of March.

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

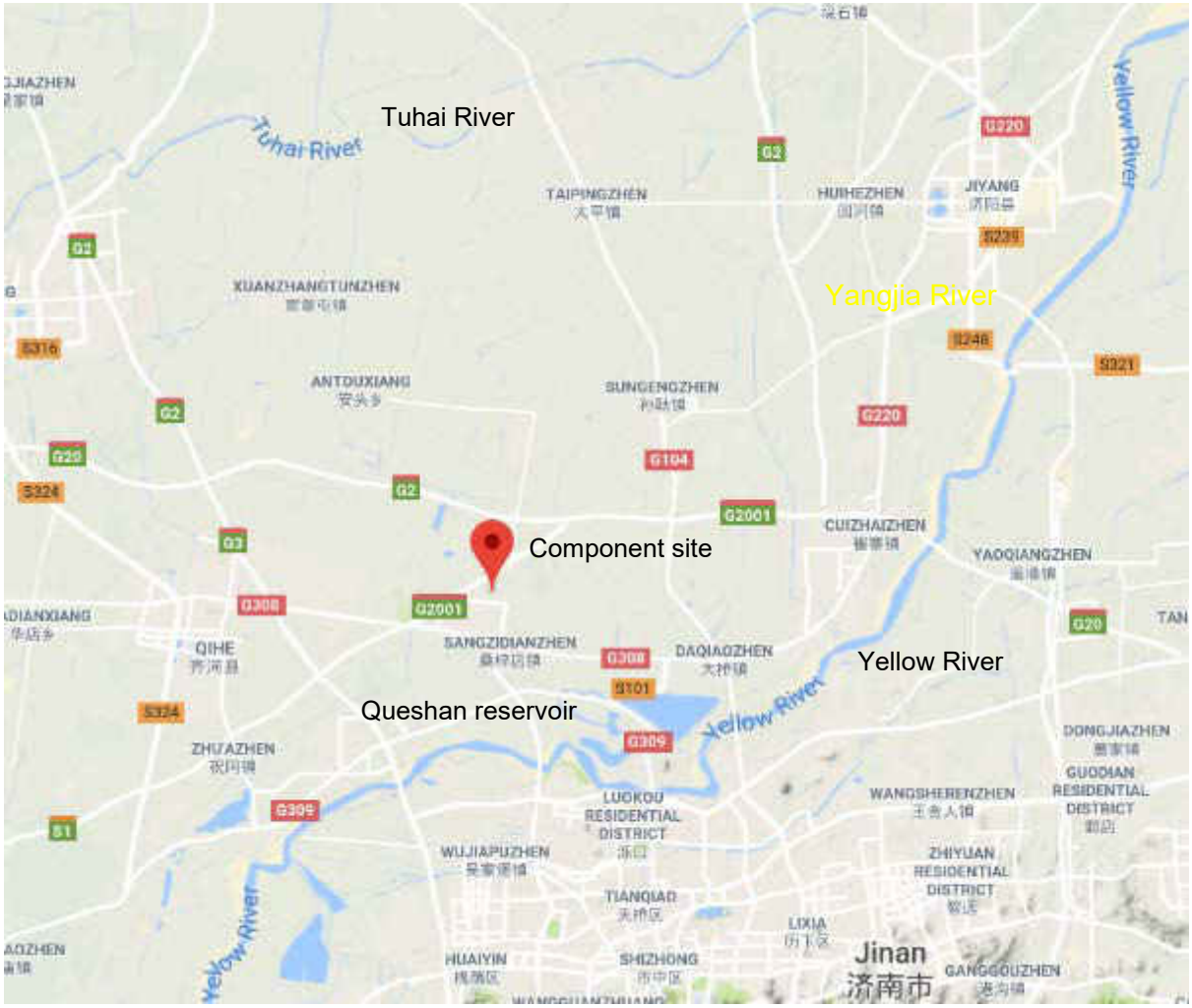
204. **Surface water - rivers and reservoirs**. Surface water resource in the component area is presented in **Figure IV-7**. Jinan lies on the south shore of the Yellow River and south of Tuhai River. Yellow River and Tuhai River are the main rivers in the component general area.

205. 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.

206. Tuhai River belongs to Hai River Basin. It originates from Henan Province, then flow through Hebei Province and Shandong Province, and then enters the Bohai Sea. In Jinan, it is 60 km long and has a watershed area of 1.465.9 km^2.

207. Water reservoirs for drinking water in Jinan include the Queshan, Yuqing, Wohushan, Langmaoshan and Jinxiuchuan. The nearest reservoir is Queshan reservoir which is about 10.1 km away from the component site in southeast direction.

Figure IV-7: Water resources in the component area



Source: Google map and domestic EIA

208. **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 in the component impact zone.

209. Annual average surface water resource of Jinan City in 2017 is 892.7933 million m^3 and underground freshwater resource is 781.7942 million m^3. The total water resource is 1,674.5875 million m^3. The per capita water resource is only 292 m^3.[12] As 100% of the extracted groundwater will be recharged back to the same aquifer, the component will not cause groundwater depletion. Production water is treated reclaimed water from WWTP of JNMIP. Therefore, the component will not exacerbate the water stress in Jinan. There are no groundwater wells within 1 km of the component site that are used as water source. The component will not drill through any groundwater source protection zone.

D. Ambient environment baseline and environmental monitoring

210. **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

211. 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**).

212. 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.

213. 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.

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

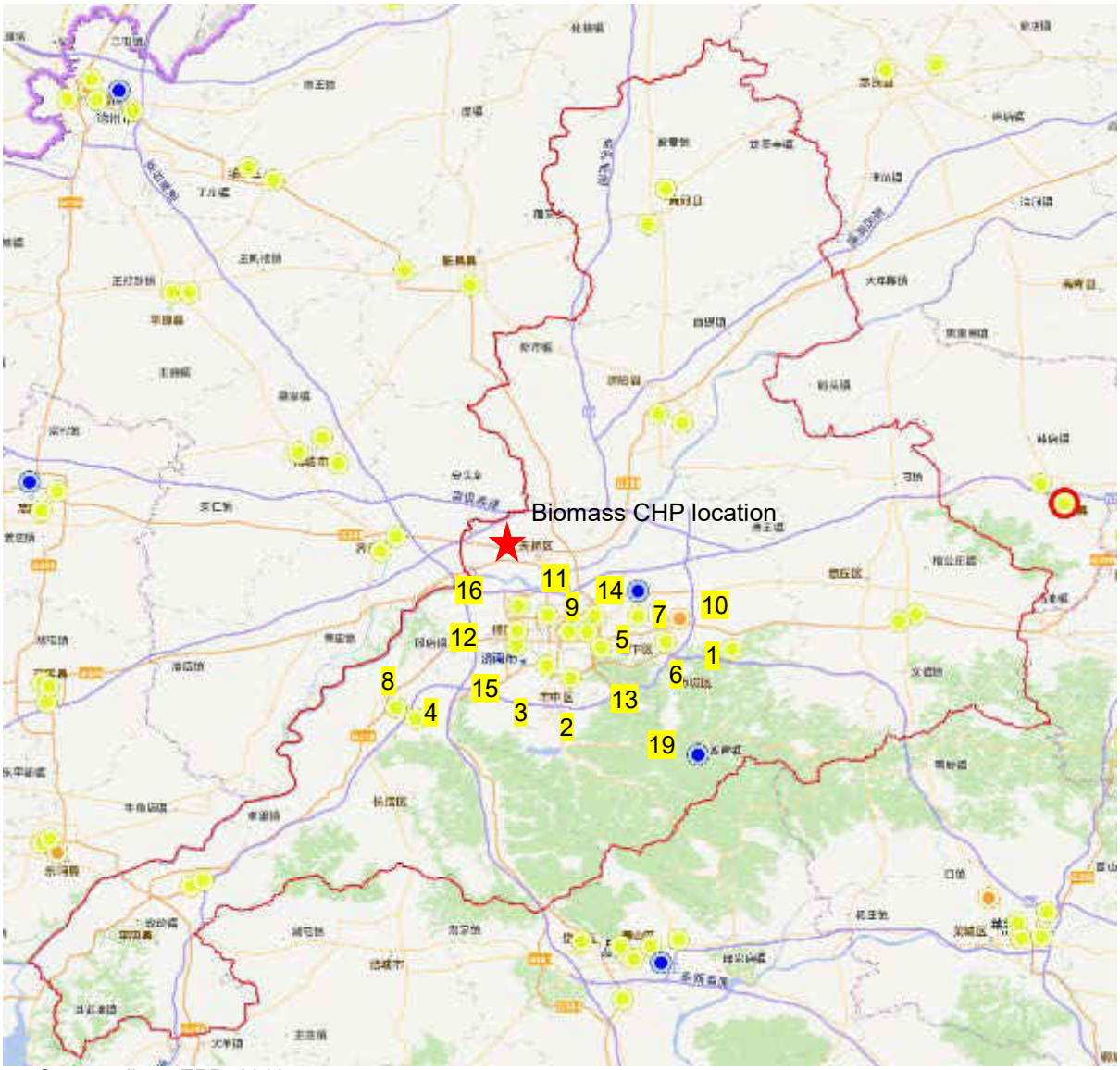
Figure IV-8: The PRC's Air Quality Index (AQI) System

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/

214. **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[13]	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

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

No.	Station name	District	No. of Good AQI days[14]	PM_{10}	$PM_{2.5}$	SO_2	NO_2	CO (mg/m^3)	O_3 (8 hours)
3	Cadre's Sanitarium	Shizhong	220	121	59	19	39	1.8	172
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.

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

215. 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 16 is the nearest station to proposed biomass CHP plant and the distance is around 11 km.

216. In 2017 average daily 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.

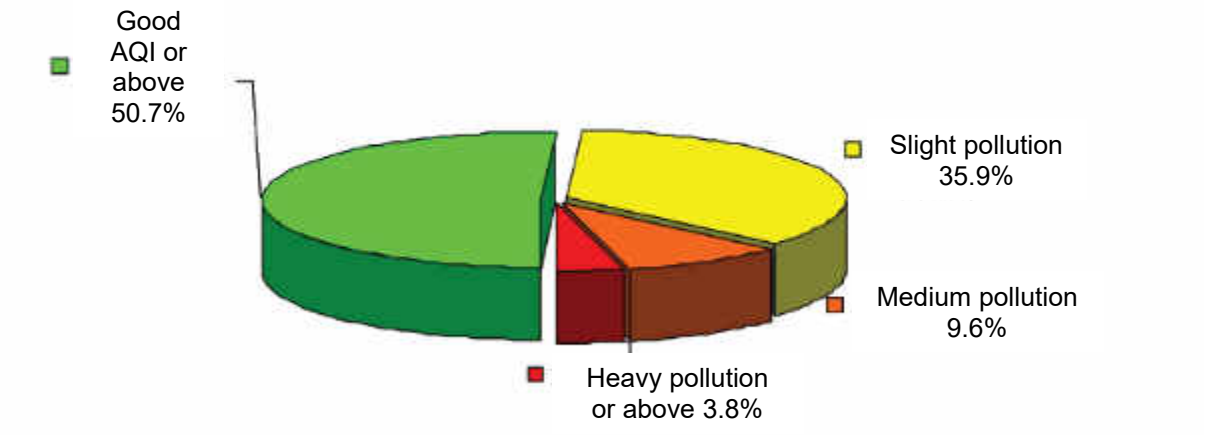
Table IV-2: Ambient Air Quality in 2017 Jinan City Urban Area (unit: μg/m^3, excluding CO)

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%
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	—	—

Source: Jinan Environmental Quality Bulletin (2017).

217. 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**.

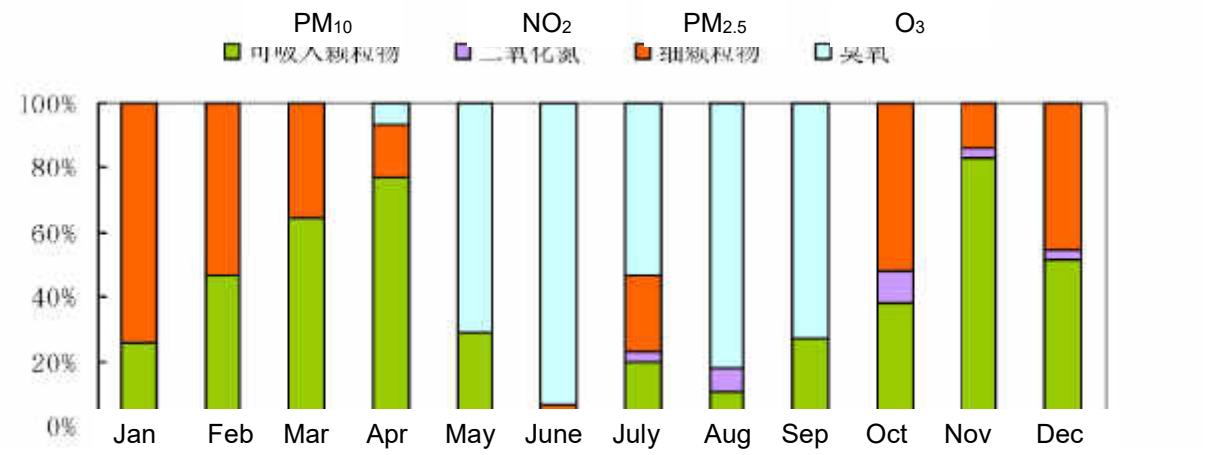
Figure IV-10: AQI Levels in Jinan, 2017



Source: Jinan Environmental Quality Bulletin (2017).

218. 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-24**).

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



Source: Jinan Environmental Quality Bulletin (2017).

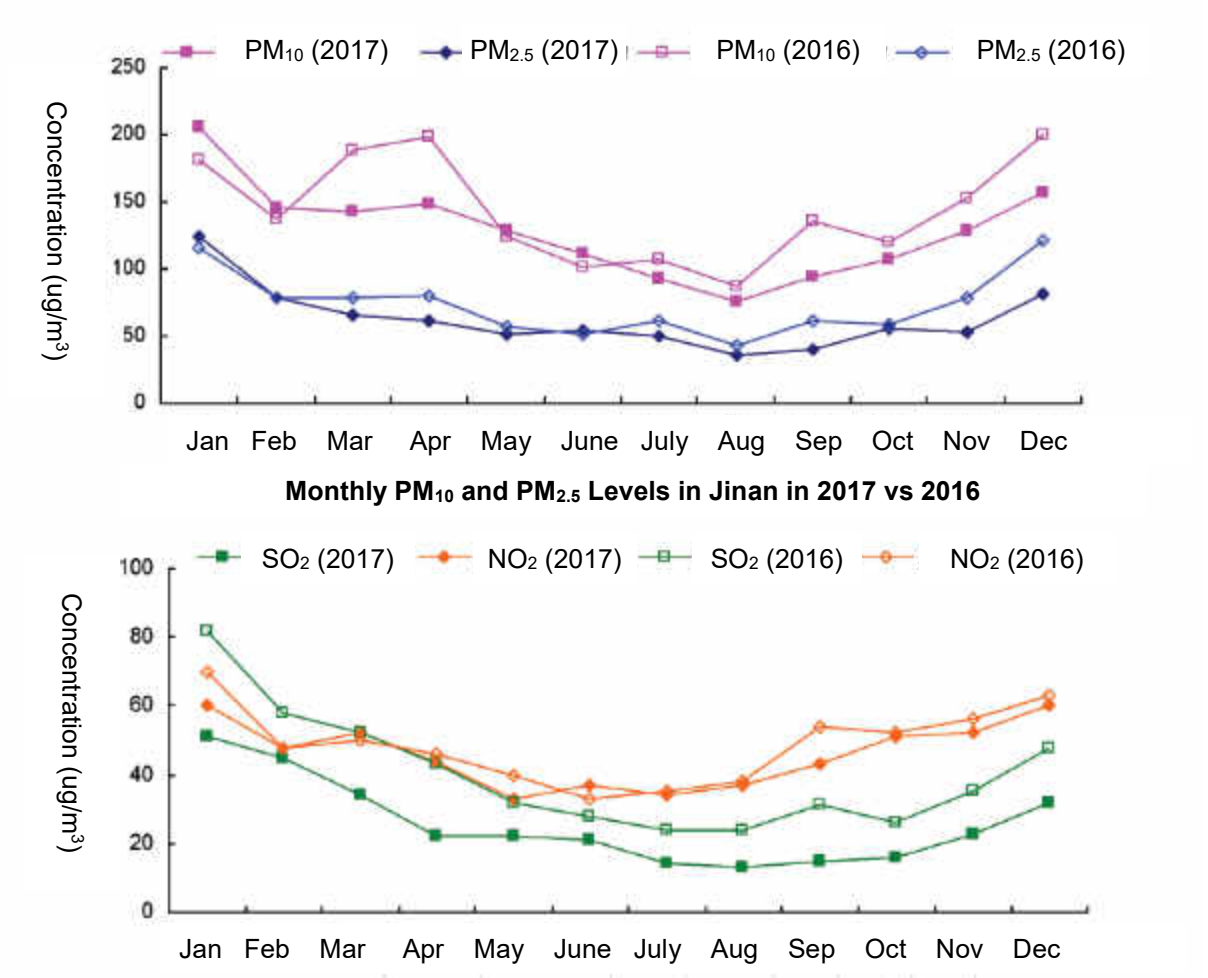
219. In 2017, MEE ranked Jinan's AQI tenth from the bottom of a list of 74 key environmental protection key cities.

220. **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).

221. 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

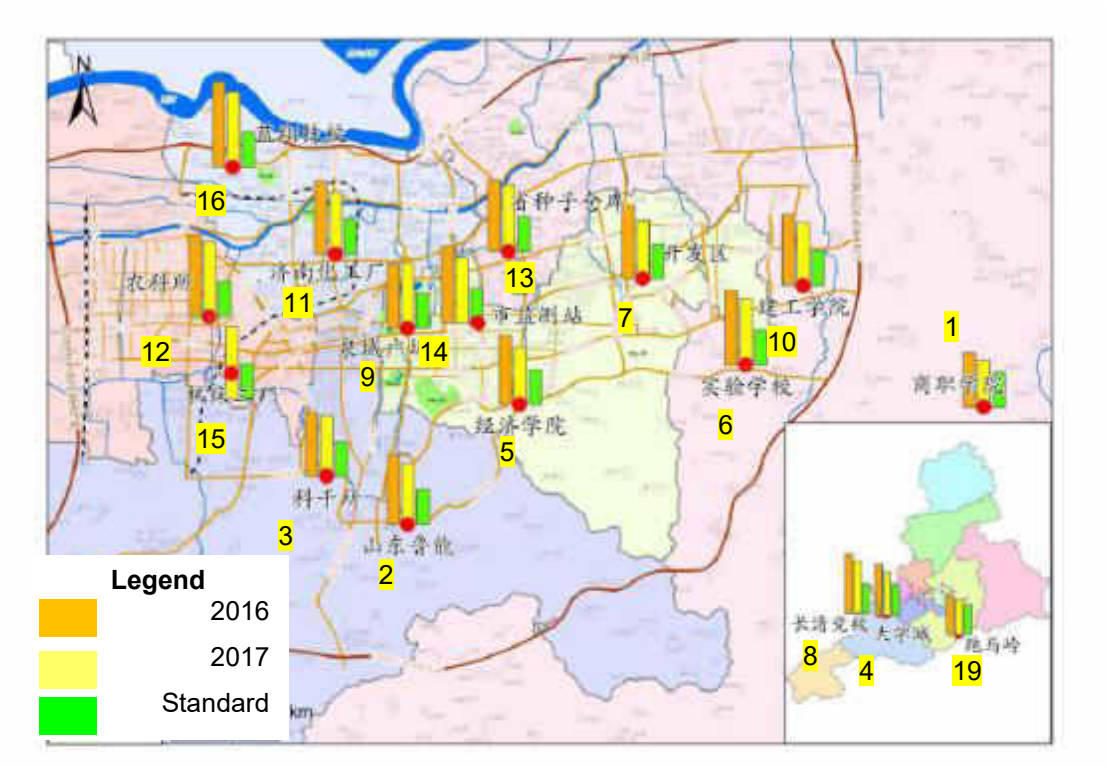


Source: Jinan Environmental Quality Bulletin (2017).

222. **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**).

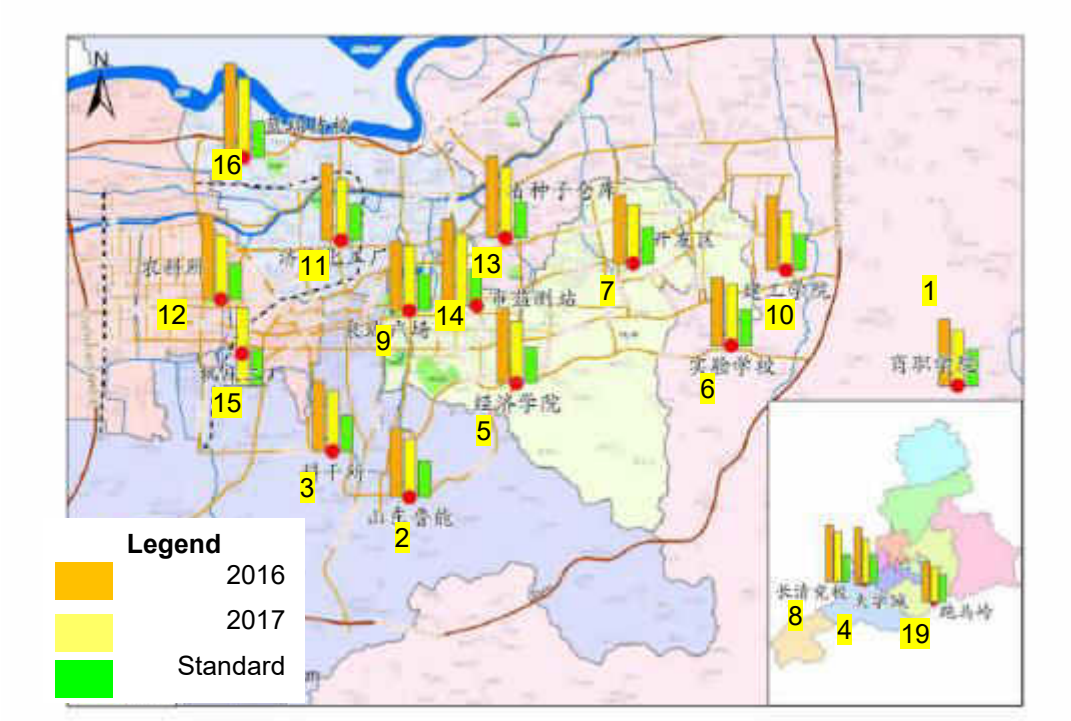
223. The annual average concentration of SO_2 met the Class II annual standard at all monitoring stations and was highest in the east and central core area, and lowest in the south (**Figure IV-15**). The annual average concentration of NO_2 exceeded the Class II annual standard at all monitoring stations 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



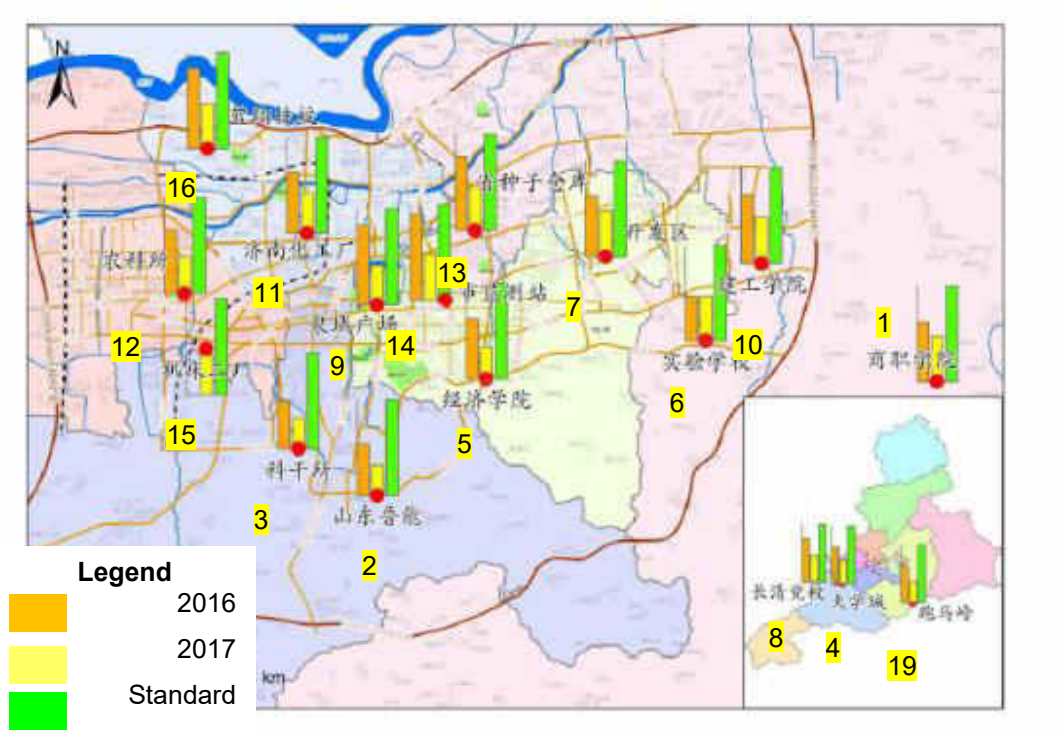
Source: Jinan Environmental Quality Bulletin (2017).

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



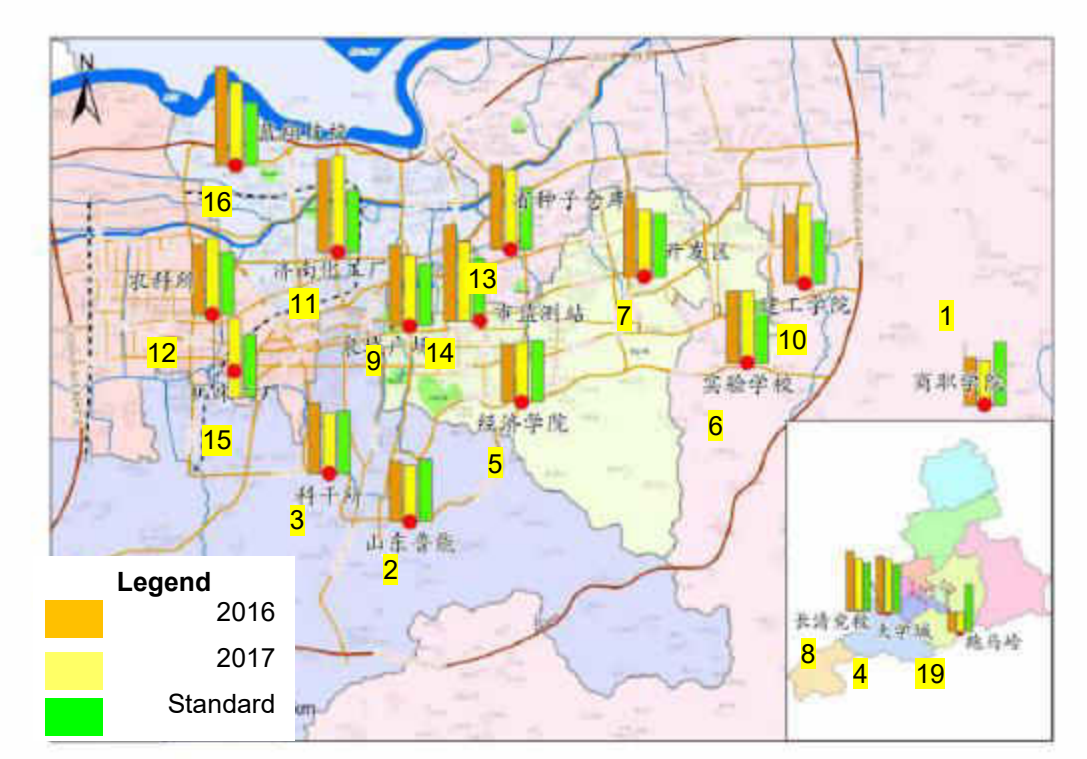
Source: Jinan Environmental Quality Bulletin (2017).

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

119. 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.

224. 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).

225. Of the 21 provincial and municipal automated air quality monitoring stations in the Jinan City proper area, 14 are in the main urban area, Station 16 is the nearest station to proposed biomass CHP plant and the distance is around 11 km.

226. As part of the domestic EIA process, baseline environmental monitoring was conducted at six locations near biomass CHP plant (**Figure IV-17** and **Table IV-4**). Monitoring was undertaken continuously over a 7 days period from March 3 to 9, 2018 (during the heating season) for CO, SO_2 and NO_2 (1-hour average concentrations), NH_3 and odor (particular pollutants) and TSP, PM_{10}, $PM_{2.5}$, SO_2 and NO_2 (24-hour average concentration). The monitoring methods are presented in **Table IV-5** .Meteorological parameters such as wind direction, wind speed, air temperature, barometric pressure and cloud cover were also monitored. The meteorological parameters are presented in **Table IV-6**.

Table IV-4: Air quality monitoring locations

No.	Location	Direction	Distance (m)	Description
1	Gaowang Village	NE	2000	Sensitive receptor at down wind direction of prevailing wind direction
2	Beiwangtang Village	NNW	1100	Sensitive receptor at down wind direction of prevailing wind direction
3	Caomiaowang Village	WSW	1200	Nearby sensitive receptor
4	Tianjia Village	SW	2500	Nearby sensitive receptor
5	Beidong Village	S	440	Sensitive receptor at up wind direction of prevailing wind direction
6	Huaizhuang Village	SSE	1600	Nearby sensitive receptor
7	Zhouyan Village	W	100	Nearby sensitive receptor

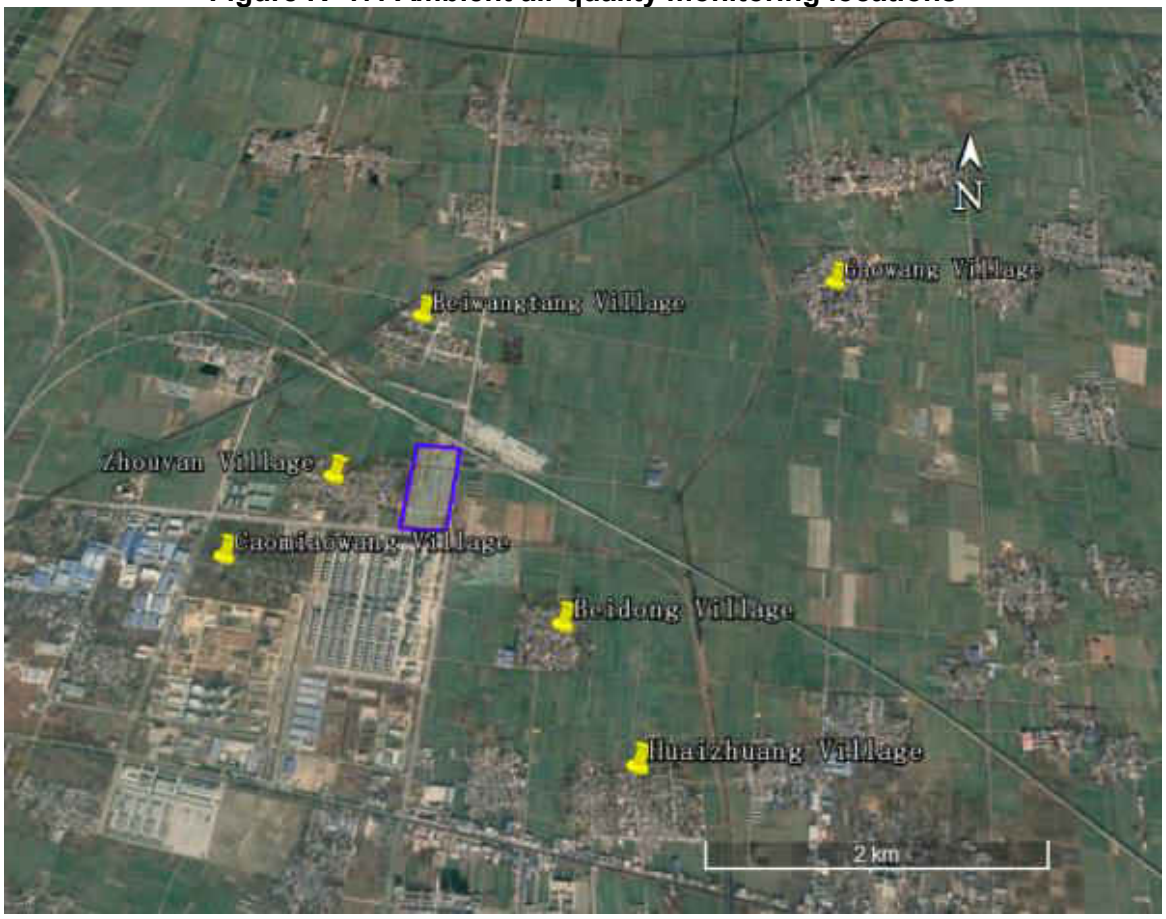
Source: Domestic EIA (2018).

Table IV-5: Air quality monitoring methods

Pollutants	Reference standard	Method	Detection limit
SO2	HJ/T482-2009	Formaldehyde absorbing-pararosaniline spectrophotometric method	1-hour mean: 0.007 mg/m^3 24-hour mean: 0.004 mg/m^3
NO2	HJ/T479-2009	Saltzman method	1-hour mean:0.005 mg/m^3 24-hour mean:0.003 mg/m^3
TSP	GB/T15432-1995	Gravimetric method	0.001mg/m^3
PM_{10}	HJ 618-2011	Gravimetric method	0.010 mg/m^3
$PM_{2.5}$	HJ 618-2011	Gravimetric method	0.010 mg/m^3
CO	GB/T9801-1988	Non-dispersive infrared spectrometry	0.3mg/m^3
NH3	HJ 533-2009	Nessler's reagent colorimetric method	0.05mg/m^3
Odor	GB/T 14675-1993	Triangle odor bag method	10

Source: Domestic EIA (2018).

Figure IV-17: Ambient air quality monitoring locations



Source: Domestic EIA and Google earth (2018).

Table IV-6: Meteorological parameters of air quality monitoring

Date		Temperature (°C)	Barometric pressure (hPa)	Wind speed (m/s)	Wind direction	Total cloud/low cloud
03.03	02:00	5.1	1009.1	1.6	NW	5/3
	08:00	2.0	1015.7	2.3	NW	6/5
	14:00	6.3	1019.2	1.3	NW	2/2
	20:00	1.7	1020.7	2.7	NE	1/1
03.04	02:00	-4.7	1022.3	0.9	NW	0/0
	08:00	-1.0	1021.2	1.2	NE	6/5
	14:00	5.9	1019.8	0.8	NW	5/5
	20:00	5.0	1029.7	1.3	NE	7/3
03.05	02:00	1.9	1021.3	2.2	SE	2/2
	08:00	2.0	1023.7	1.3	SW	10/0
	14:00	8.7	1027.2	1.6	SE	5/4
	20:00	5.0	1021.9	2.7	SE	8/4
03.06	02:00	2.0	1022.3	1.9	SW	1/1
	08:00	2.3	1023.1	2.7	SW	1/1
	14:00	12.0	1021.7	3.9	SE	0/0
	20:00	7.0	1022.3	1.9	SE	2/2
03.07	02:00	5.9	1019.9	3.2	SW	1/1
	08:00	3.8	1021.2	2.7	SE	0/0
	14:00	13.7	1022.2	0.9	SE	5/4
	20:00	9.2	1019.3	1.3	SW	3/2
03.08	02:00	7.2	1012.9	2.2	SE	6/5
	08:00	6.8	1013.7	3.0	NE	2/2
	14:00	10.7	1016.9	1.9	NW	7/4
	20:00	9.0	1020.2	1.6	NW	2/2
03.09	02:00	6.2	1010.7	2.0	MW	1/1
	08:00	5.9	1012.6	1.9	NE	0/0

Date	Temperature (°C)	Barometric pressure (hPa)	Wind speed (m/s)	Wind direction	Total cloud/low cloud	Date
	14:00	11.0	1013.6	2.0	SW	0/0
	20:00	6.2	1017.2	2.3	SW	1/1

Source: Domestic EIA (2018).

227. The monitoring results are presented in **Table IV-7** and summarized in **Table IV-8**. The data show that all 24-hour average SO_2, NO_2 concentrations and 1-hour average SO_2, NO_2, PM_{10} and $PM_{2.5}$ concentrations were in compliance with the relevant PRC ambient air quality standard, Class II of *Ambient Air Quality Standards (*GB3095-2012). 24-hour average PM_{10}, $PM_{2.5}$ and TSP concentrations were not in compliance with relevant PRC standard. 76.2% of $PM_{2.5}$, 59.5% of PM_{10} and 40.5% of TSP 24-hour concentrations exceeded relevant standard and the worst case $PM_{2.5}$, PM_{10} and TSP concentration were 1.67, 1.39 and 1.19 times of relevant standard respectively.

228. The results show that air quality in the component area is poor, with 24-hour mean concentrations of PM_{10}, $PM_{2.5}$ and TSP exceeding PRC standards.

Table IV-7: Air quality monitoring results (mg/m^3)

No.	Item	Sample No.		1-hour mean concentration rage	24-hour mean concentration rage	Exceedance of national standards /WHO guidelines, %	
		1-hour mean	24-hour mean			1-hour mean	24-hour mean
1	SO_2	28	7	0.034 - 0.092	0.045-0.058	0/NA	0/100
	NO_2	28	7	0.022-0.059	0.029-0.040	0/0	0/NA
	CO	28	—	1.0-3.7	—	0/NA	—
	$PM_{2.5}$	—	7	—	0.065-0.114	—	71.4/100
	PM_{10}	—	7	—	0.124-0.201	—	57.1/100
	TSP	—	7	—	0.225-0.354	—	57.1/NA
2	SO_2	28	7	0.027-0.105	0.046-0.065	0/NA	0/100
	NO_2	28	7	0.022-0.065	0.030-0.047	0/0	0/NA
	CO	28	—	0.9-4.0	—	0/NA	—
	$PM_{2.5}$	—	7	—	0.069-0.118	—	71.4/100
	PM_{10}	—	7	—	0.120-0.199	—	42.9/100
	TSP	—	7	—	0.224-0.354	—	57.1/NA
	NH_3	28	—	0.05-0.16	—	0/NA	—
3	SO_2	28	7	0.026-0.092	0.040-0.056	0/NA	0/100
	NO_2	28	7	0.021-0.065	0.026-0.049	0/0	0/NA
	CO	28	—	0.4-3.5	—	0/NA	—
	$PM_{2.5}$	—	7	—	0.068-0.115	—	71.4/100
	PM_{10}	—	7	—	0.124-0.186	—	42.9/100
	TSP	—	7	—	0.227-0.324	—	28.6/NA
4	SO_2	28	7	0.030-0.095	0.050-0.063	0/NA	0/100
	NO_2	28	7	0.021-0.062	0.027-0.045	0/0	0/NA
	CO	28	—	0.6-3.3	—	0/NA	—
	$PM_{2.5}$	—	7	—	0.055-0.097	—	71.4/100
	PM_{10}	—	7	—	0.107-0.175	—	42.9/100
	TSP	—	7	—	0.204-0.302	—	14.3/NA
5	SO_2	28	7	0.029-0.096	0.051-0.072	0/NA	0/100
	NO_2	28	7	0.020-0.059	0.032-0.051	0/0	0/NA
	CO	28	—	1.0-3.3	—	0/NA	—
	$PM_{2.5}$	—	7	—	0.072-0.125	—	85.7/100

No.	Item	Sample No.		1-hour mean concentration rage	24-hour mean concentration rage	Exceedance of national standards /WHO guidelines, %	
		1-hour mean	24-hour mean			1-hour mean	24-hour mean
	PM_{10}	—	7	—	0.119-0.209	—	57.1/100
	TSP	—	7	—	0.223-0.348	—	42.9/NA
	NH_3	28	—	0.06-0.14	—	0/NA	—
	Odor	3	—	0-11	—	0/NA	—
6	SO_2	28	7	0.028-0.108	0.046-0.069	0/NA	0/100
	NO_2	28	7	0.020-0.067	0.033-0.048	0/0	0/NA
	CO	28	—	1.0-4.0	—	0/NA	—
	$PM_{2.5}$	—	7	—	0.071-0.113	—	85.7/100
	PM_{10}	—	7	—	0.123-0.199	—	71.4/100
	TSP	—	7	—	0.219-0.335	—	42.9/NA

* WHO has no guideline value for 1-h SO_2, PM_{10}, $PM_{2.5}$, NH_3 and CO and, 24-h TSP, NO_2 and CO
Source: Domestic EIA.

Table IV-8: Summary of air quality monitoring results

Item	1-hour mean concentration				24-hour mean concentration			
	Sample No.	Concentration rage(mg/m^3)	Exceedance of national/WHO limit, %	Worst case exceedance of limit	Sample No.	Concentration rage (mg/m^3)	Exceedance of national and WHO limit, %	Worst case exceedance of limit
SO_2	168	0.026-0.108	0/NA	—	42	0.040-0.072	0/100	0/2.6
NO_2	168	0.020-0.067	0/0	—	42	0.026-0.051	0/NA	—
CO	168	0.4-4.0	0/NA	—	0-	—	—	—
$PM_{2.5}$	0	—	—	—	42	0.055-0.125	76.2/100	0.67/4
PM_{10}	0	—	—	—	42	0.107-0.209	59.5/100	0.39/3.02
TSP	0	—	—	—	42	0.204-0.357	40.5/NA	0.19/NA
NH_3	12	0.05-0.16	0/NA	—	0	—	—	—

Source: Domestic EIA.

3. Groundwater quality

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

230. 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 20.8 km away from the biomass CHP plant in southeast direction while Dongjiao Water Plant is 18.6 km

away in south 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 and increased slightly, 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-9**).

Table IV-9: 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
Name	Year	pH	Total hardness	Sulfate	Permanganate index	NO_3-N	NO_2-N	NH_3	Fluoride	Conductivity
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).

231. 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 18.8 km away from the biomass CHP plant in southeast direction. All parameters for 2016 and 2017 complied with the Class III standard of Underground Water Quality Standard (GB/T 14848－2017) (**Table IV-10**).

Table IV-10: 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).

232. Ground water monitoring was implemented in domestic EIA. In the component site, ground

water flow is from southwest to northeast. Three monitoring points were selected based on ground water flow direction. The samples were taken from three existing groundwater monitoring wells which are for irrigation. The monitoring points are presented in **Table IV-11** and **Figure IV-18**.

Table IV-11: Groundwater Quality Monitoring Locations

No.	Name	Direction	Distance (m)	Description	Depth (m)
1	Caomiaowan Village	WSW	1200	Up stream	30.2
2	Zhouyan Village	W	500	Side flow	10.4
3	Gaowang Village	NE	2000	Down stream	31.5

Source: Domestic EIA (2018).

Figure IV-18: Groundwater Quality Monitoring Locations

Source: Domestic EIA (2018).

233. Groundwater samples were taken on 8 March 2015. One sample was taken at each location by Shandong Analysis and Testing Center. Lab analysis results are presented in **Table IV-12**. The results indicate that groundwater quality at the sample locations around the CHP plant is in compliance with the relevant PRC standard, Class III of *GB/T14848-2017 Quality Standards for Ground Water.* As the sampling was conducted three years ago, during construction/drilling, groundwater testing will be conducted during construction.

Table IV-12: Groundwater Quality Monitoring Results. (Unit: μg/L, except pH)

Item	No.1 monitoring point	No.2 monitoring point	No.3 monitoring point	Limit
pH	7.57	7.3	7.26	6.5-8.5
Total hardness	413	357	256	450
Chloride	82.3	164	240	250
Cyanide	ND	ND	ND	0.05
Fluoride	0.72	0.48	0.73	1.0
Arsenic	0.0004	0.0022	ND	0.01
Mercury	ND	ND	ND	0.001
Cadmium	ND	ND	ND	0.005
Item	No.1 monitoring point	No.2 monitoring point	No.3 monitoring point	Limit
Chromium VI	ND	ND	ND	0.05
Lead	ND	ND	ND	0.01
Total dissolved solid	625	748	801	1000
COD_{Mn}	1.61	1.15	1.54	3.0
Sulfate	241	142	150	250
Total coliforms	ND	ND	ND	3
NH_3-N	0.02	0.1	0.03	0.5
Nitrate NO_{3-}	0.03	0.09	0.08	20
Nitrite NO_{2-}	ND	ND	ND	0.1
Volatile Phenols	ND	ND	ND	0.002

Note: ND means no detection.
Source: Domestic EIA (2018).

4. Surface water quality

234. 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.

235. **Table IV-13** presents a summary of water quality compliance with Surface Water Environmental Quality Standard (GB3838－2002), Jinan City, 2017.

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

237. 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 standards. 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).

238. 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.

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

240. 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.

241. 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-13: 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

Water Body	Section	Applicable Standards	Compliance Status	Actual Water Quality Category	Exceedance parameter
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).

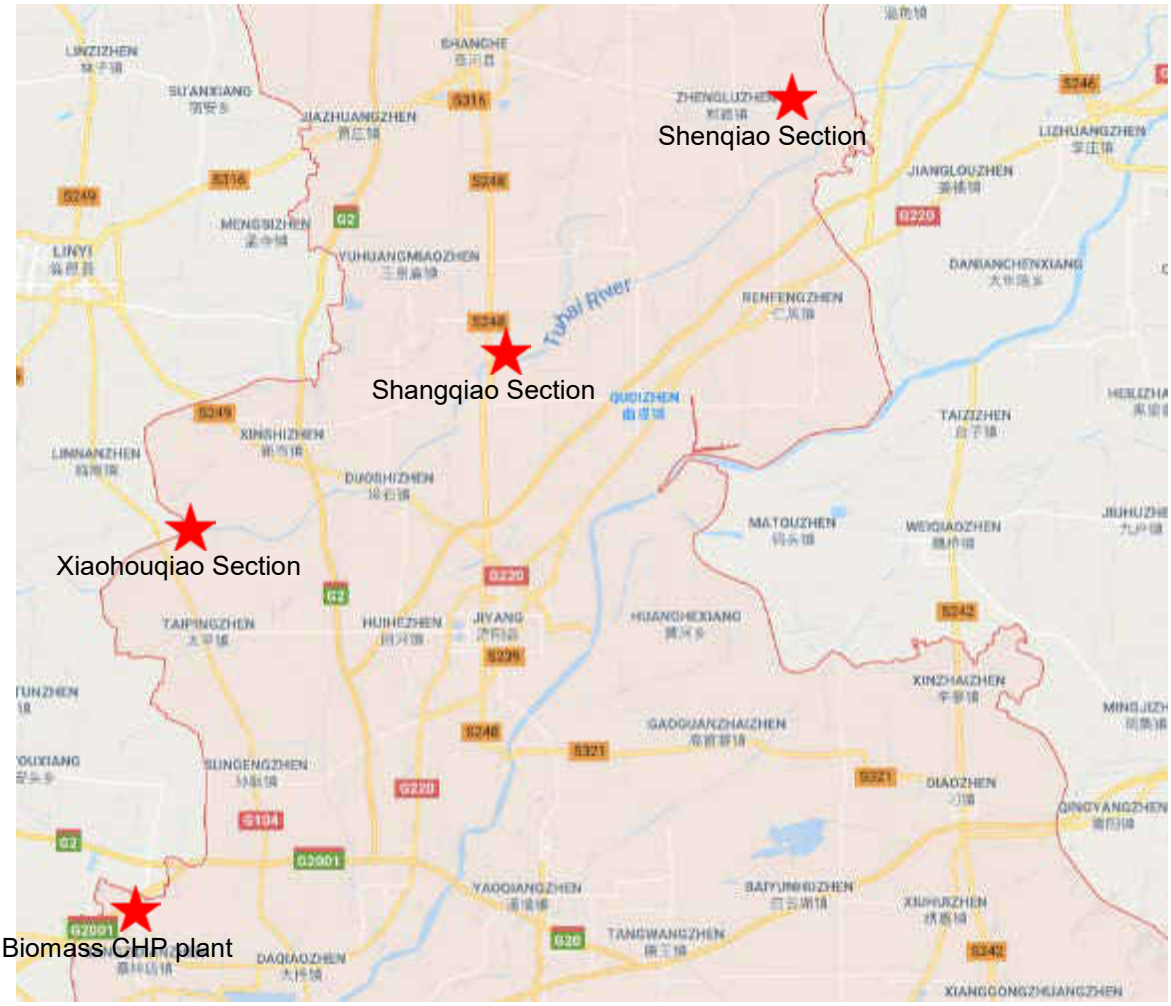
242. Based on site visit, the surface water body near the component site is Tuhai River (28.5 km away in north direction) and Yellow River (6.5 km away in south direction) (**Figure IV-7**).There is no small local pond or drain in a radius of 500m near biomass CHP plant. Three sections of Tuhai River are monitored (**Figure IV-19**). Because the wastewater of the component will be treated in WWTP of JNMIP then finally discharged to Tuhai River. Based on Jinan Environmental Quality Bulletin (2017), water quality of Tuhai River is presented below:

243. In 2017, annual average concentrations of COD and NH_3-N in Xiahouqiao Section (entry section) were 21 mg/L and 0.64 mg/L respectively. Compared to 2016, COD is consistent and NH_3-N decreased by 48.0%.

244. In 2017, annual average concentrations of COD and NH_3-N in Shangqiao Section (middle section) were 21 mg/L and 0.30 mg/L respectively. Compared to 2016, COD decreased by 10.8% and NH_3-N decreased by 62.3%.

245. In 2017, annual average concentrations of COD and NH_3-N in Shenqiao Section (exit section) were 20 mg/L and 0.24 mg/L respectively. Compared to 2016, COD decreased by 21.0% and NH_3-N decreased by 57.1%.

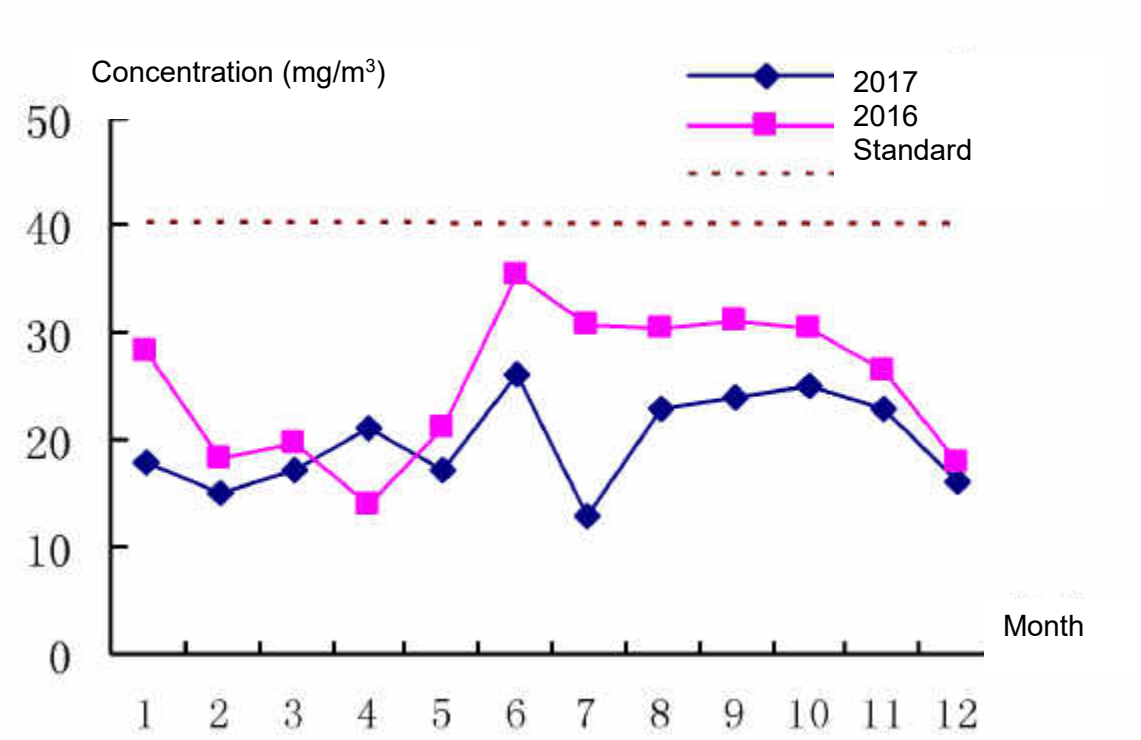
Figure IV-19: Monitoring sections of Tuhai River



Source: Jinan Environmental Quality Bulletin (2017).

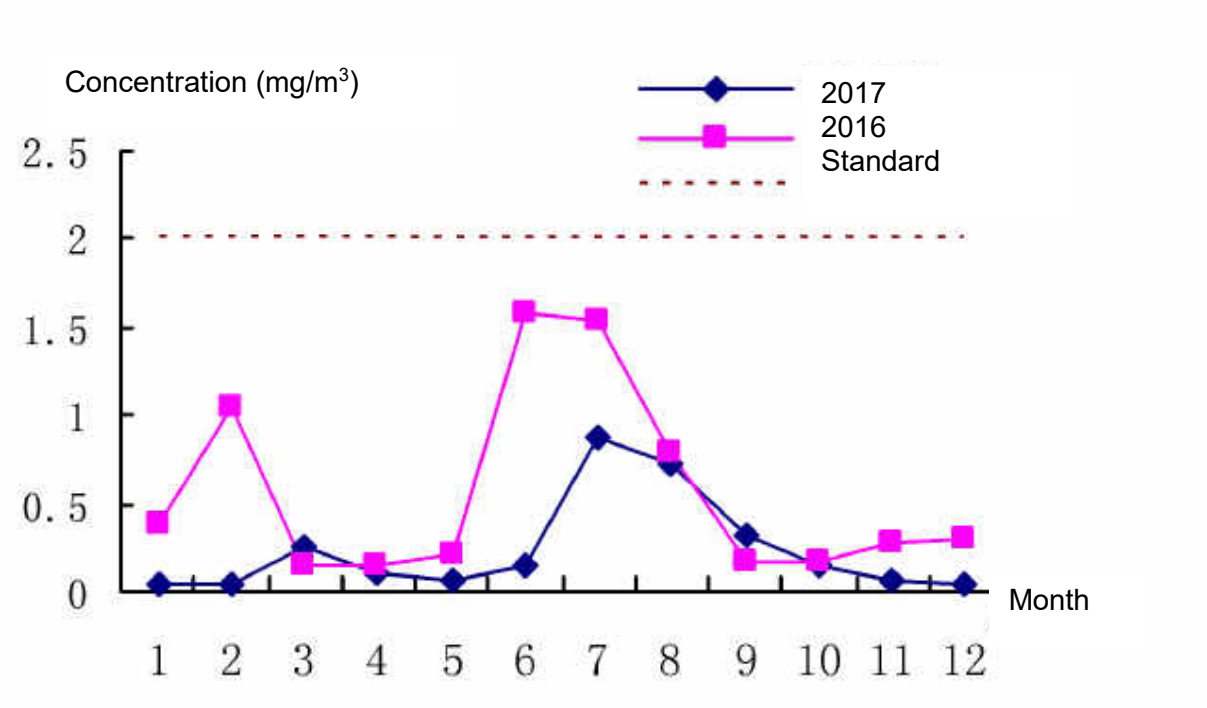
246. In 2017, monthly average concentration range of COD and NH_3-N in Shenqiao Section (exit section) were 13-26 mg/L and 0.04-0.87 mg/L respectively (**Figure IV-20** and **Figure IV-21**). Water quality comply with standards of Provincial control assessment section on transboundary rivers.

Figure IV-20: Monthly average COD concentrations of Shenqiao Section



Source: Jinan Environmental Quality Bulletin (2017).

Figure IV-21: Monthly average NH_3-N concentrations of Shenqiao Section



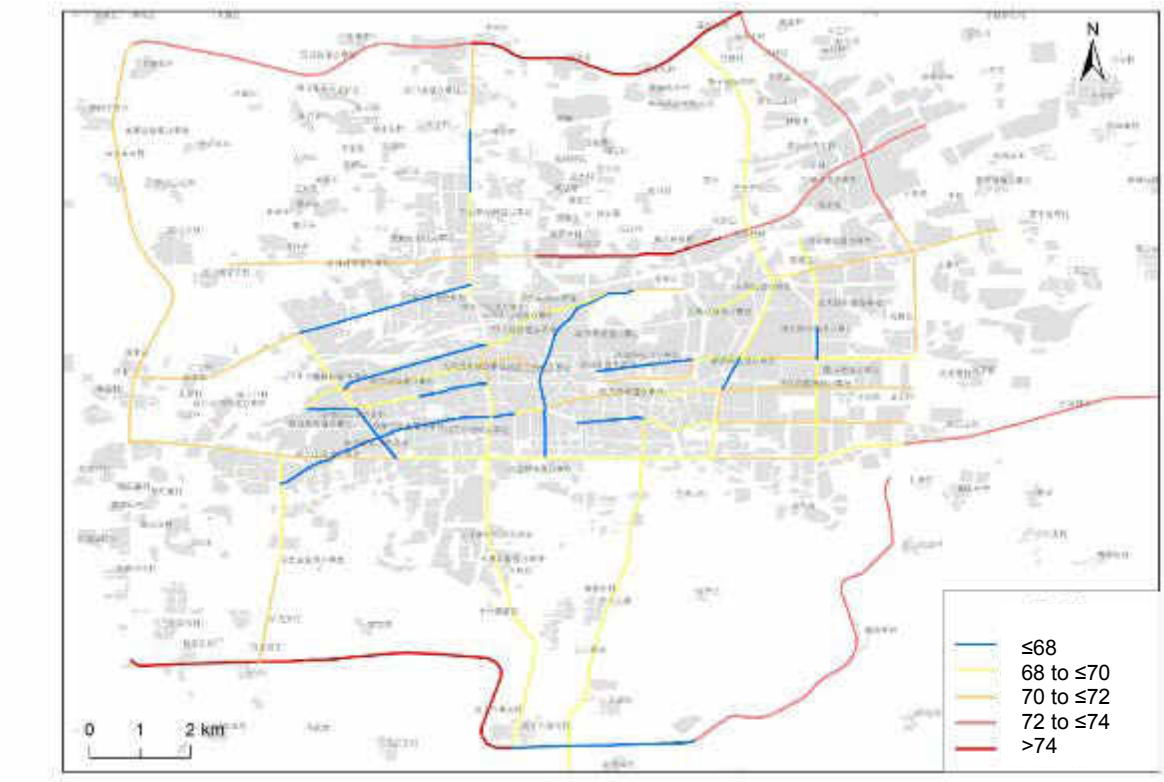
Source: Jinan Environmental Quality Bulletin (2017).

5. Noise

247. **Urban noise.** There were 214 urban noise monitoring sites in Jinan in 2017. The annual average 12-hour daytime noise level in 2016 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.

248. **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-22**).

Figure IV-22: Results of Traffic Noise Monitoring in Jinan, 2017



Source: Jinan Environmental Quality Bulletin (2017).

249. Noise monitoring was implemented at the biomass CHP plant boundaries and adjacent sensitive site. The monitoring was carried out at over a 24-hour period on January 19, 2018. Weather conditions were sunny and cloudless with wind speed less than 5.0 m/s, which is in compliance with relevant PRC meteorological requirements for noise monitoring.

250. Monitoring was undertaken with HS 6298 and Aiwa AWA6218 multi-functional ambient noise detectors. Monitoring at the biomass CHP plant site boundaries was undertaken in accordance with the relevant requirements in *PRC Noise Standards for Industrial Enterprises at*

Site Boundary (GB12348-2008). Noise monitoring at adjacent sensitive sites was undertaken in accordance with the relevant requirements in PRC *Environmental Quality Standards for Noise* (GB3096-2008). **Figure IV-23** presents the location of the monitoring points (site boundaries and adjacent sensitive locations). **Table IV-14** presents the monitoring results.

Figure IV-23: Noise Monitoring location

Source: Domestic EIA (2018).

Table IV-14: Monitoring Results of Noise at Site Boundaries (unit: Leq dB(A))

Date	Monitoring period	Monitoring results				Limit	Monitoring results	Limit
		No.1	No.2	No.3	No.4		No.5	
January 19, 2018	Daytime	51.7	54.4	55.6	53.1	65	49.0	55
	Nighttime	37.5	44.1	38.3	30.3	55	36.0	45

Source: Domestic EIA (2018).

251. The results indicate that daytime and nighttime noise levels at the at the site boundaries meet the applicable Class III standards (65 dB(A) daytime, 55 dB(A) nighttime) in *PRC Noise Standards for Industrial Enterprises at Site Boundary* (GB12348-2008). The results also indicate that daytime and nighttime noise levels at the adjacent sensitive locations meet the applicable Class I standards (55 dB(A) daytime, 45 dB(A) nighttime) in *PRC Environmental Quality Standards for Noise* (GB3096-2008).

E. Ecology and Sensitive Resources

252. **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.

253. 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.

254. The component is located in existing industrial zone, a developing and modified industrial environment and there are no known ecological and/or sensitive resources in or near the component site. Land acquisition was completed 4 years ago.

255. Transmission line will be lain in existing cable trench owned by Shandong Electric Power Group Corporation. The existing cable trench is 2m high and 2.5m width and is buried beneath existing Xinyuan Road. The route of the cable trench is presented in **Figure III-15**.

256. The component site and supporting pipeline routes (heating, reclaimed water and power transmission line) are in existing highly developed industrial zone with little or no vegetation cover (**Figure IV-24**). Original vegetation cover has been previously removed, and existing site vegetation is typically completely absent as they are developed industrial sites, or disturbed dirt with little or no vegetation cover.

Figure IV-24: Component site conditions

(i) Construction site is covered for and dust control

(ii) Road at the east of component site

(iii) Component site is fenced.

(iv) Nearby Zhouyan Village.

(v) Xingejiayuan Community – heating user of the component.

(vi) Dingxin Community – heating user of the component.

(vii) Xinyuan Road where power transmission line and reclaimed water pipeline will be built.

(viii) Zidong Road where heating pipeline of will be built.

257. 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,[15] 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, or, based on both sites surveys and a review of relevant literature, sites with Physical Cultural Resources (PCRs).[16]

258. **Sensitive receptors.** The domestic EIA report identifies 8 sensitive receptors for air and noise impacts near the component site during construction phase and operation phase (**Table IV-15**) and 10 sensitive receptors for air and noise impacts during pipeline construction (**Table IV-16**).

Table IV-15: Sensitive receptors near the biomass plant

No.	Location	Direction	Distance (m)
1	Gaowang Village	NE	2000
2	Beiwangtang Village	N	900
3	Caomiaowang Village	SW	1200
4	Tianjia Village	S	2500
5	Beidong Village	SE	440
6	Huaizhuang Village	SE	1600
7	Zhouyan Village	W	100
8	JNMIP	SW	450

Source: Domestic EIA (2018).

[15] 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).

[16] 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).

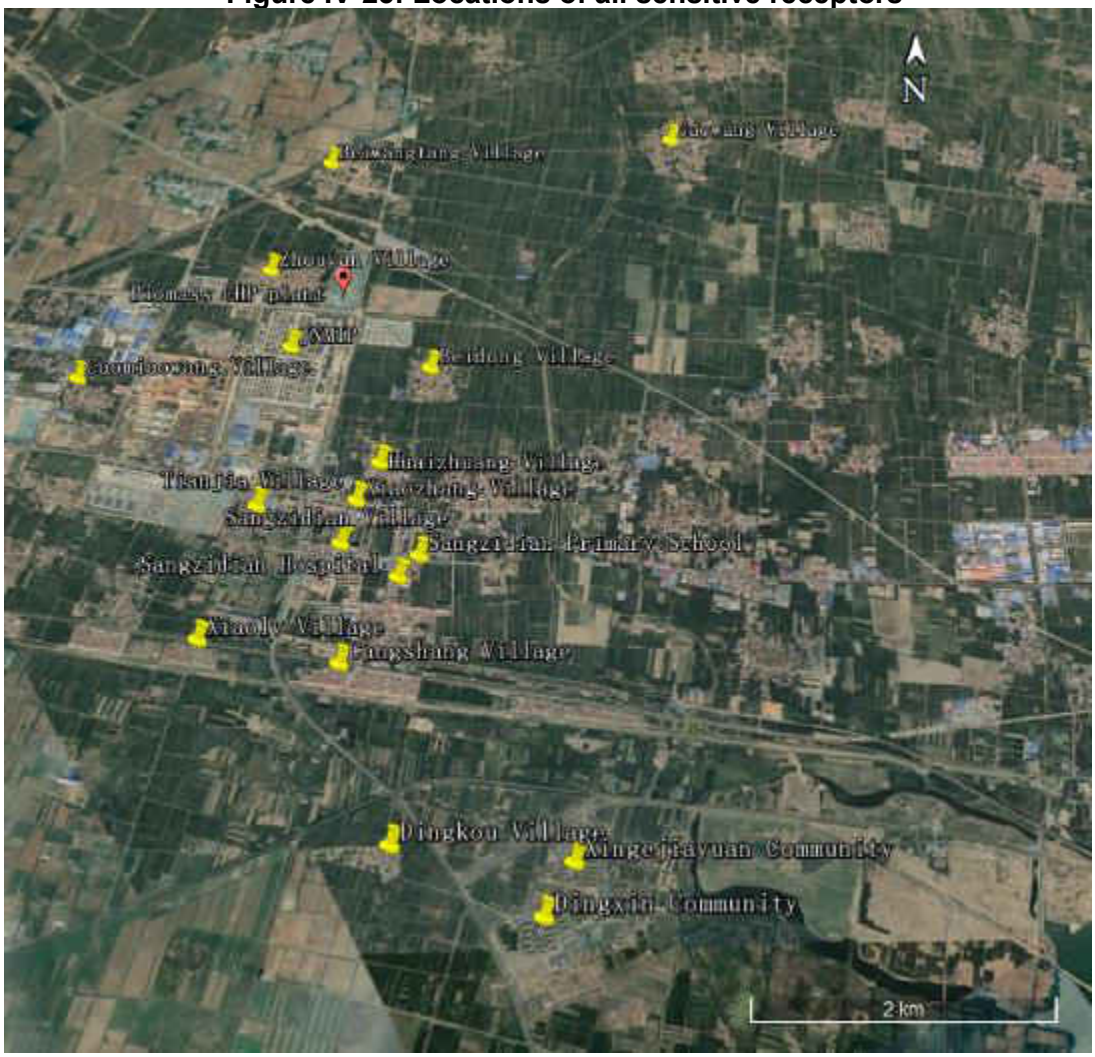
Table IV-16: Sensitive receptors near the pipeline route

No.	Location	Direction	Distance (m)
1	Sangzidian Village	E	200
2	Sangzidian Primary School	SE	1200
3	Sangzidian Hospital	E	800
4	Xiaozhang Village	E	260
5	Tianjia Village	W	300
6	Xiaolv Village	W	520
7	Cangshang Village	E	180
8	Dingkou Village	W	300
9	Xingejiayuan Community	SE	350
10	Dingxin Community	SE	550

Source: Domestic EIA (2018).

259. Locations of all sensitive receptors are presented in **Figure IV-25**. Sensitive receptors are given special attention in the assessment of impacts (Section V) and the EMP (Appendix I).

Figure IV-25: Locations of all sensitive receptors



F. Socio-economic and Cultural Resources

260. **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-26**). The city has a total area of 8,177 km^2.

261. Total population was 6,328,300 by the end of 2017 (**Table IV-17**).

Figure IV-26: Map of Jinan City administrative divisions

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

Table IV-17: Data on Jinan City administrative divisions

Subdivision	Land Area (km²)	Population (2016)	Population Density (persons/km²)
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

262. 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. None of the ethnic groups will be affected by the component implementation.

263. **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.

264. In 2017, the city's GDP was CNY720.196 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.

265. **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%.

266. **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.

267. **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.

268. 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.

269. 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.

270. 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.

271. **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 generally in compliance with applicable standards.

272. 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.

273. **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.

274. Jinan has a rich history. However, the component activities are all on long developed sites within highly developed and modified industrial 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

275. 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.

276. 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.

277. Potential negative environmental impacts during the construction phase are short-term and localized, and are associated with construction noise, fugitive dust, 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.

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

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

1. Siting and Land Acquisition

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

(i) Based on PPTA social specialist's work, up to now, compensation work for land acquisition of the CHP Plant has been completed and all compensation fees have been paid off. The certificate for the use of state-owned land has been obtained. Land acquisition has been completed for those components in which new facilities will be constructed, and was found to be in compliance with PRC and ADB requirements

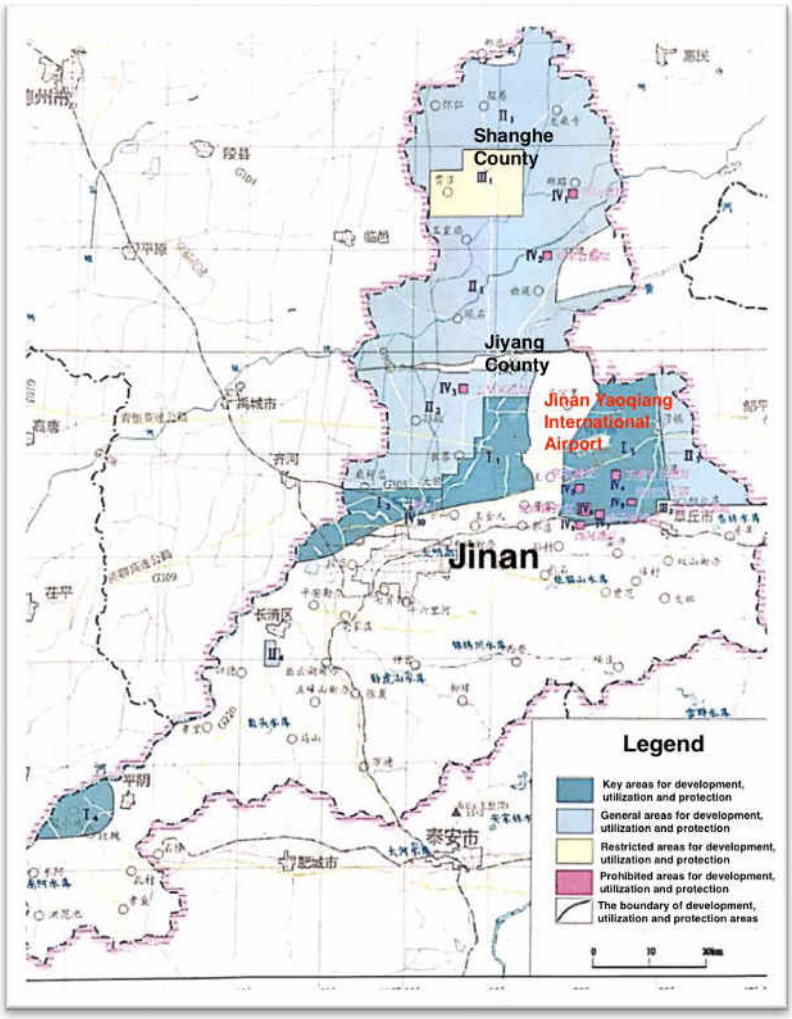
(ii) The compensation rates, resettlement program, and compensation distribution program of the proposed plant have been determined through repeated consultations. Compensation for acquired land has been paid to the affected households timely and in full. As a result, there has been no complaint to the grievance redress mechanism. The compensation rates and resettlement program comply with the applicable state and provincial regulations and policies, and ADB's involuntary resettlement safeguard principles. The APs are satisfied with the resettlement policies, and their income has risen, demonstrating that the resettlement program of the proposed plant has been effective.

280. 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. Geothermal utilization

281. Jinan's geothermal resources as shown in **Figure V-1**. The component is located at key areas for development, utilization and protection.

Figure V-1: Geothermal Sources in Jinan



3. Mitigation Measures and Monitoring during Detailed Design

282. 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 EIA, 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 EIA, 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.

4. Grievance Redress Mechanism

283. In accordance with the GRM presented in Chapter VIII of the EIA, 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 CHP plant.

5. Training and Capacity Building

284. 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.

6. Permitting

285. All necessary permits have been obtained from the relevant authorities.

B. Anticipated Environmental Impacts and Mitigation Measures during Construction Phase

286. Potential impacts during the construction phase could include air pollution, noise, water pollution, solid waste and poor occupational health and safety practices. 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

287. 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 industrial environments with little or no vegetation cover other than recently established grasses and shrubs. It was found in the survey that the component site is agricultural farm land before 2014 and after the land acquisition in 2014, the site is transferred to industrial land. It is therefore unlikely that there will be direct impacts on natural lands or ecological values from component site developments.

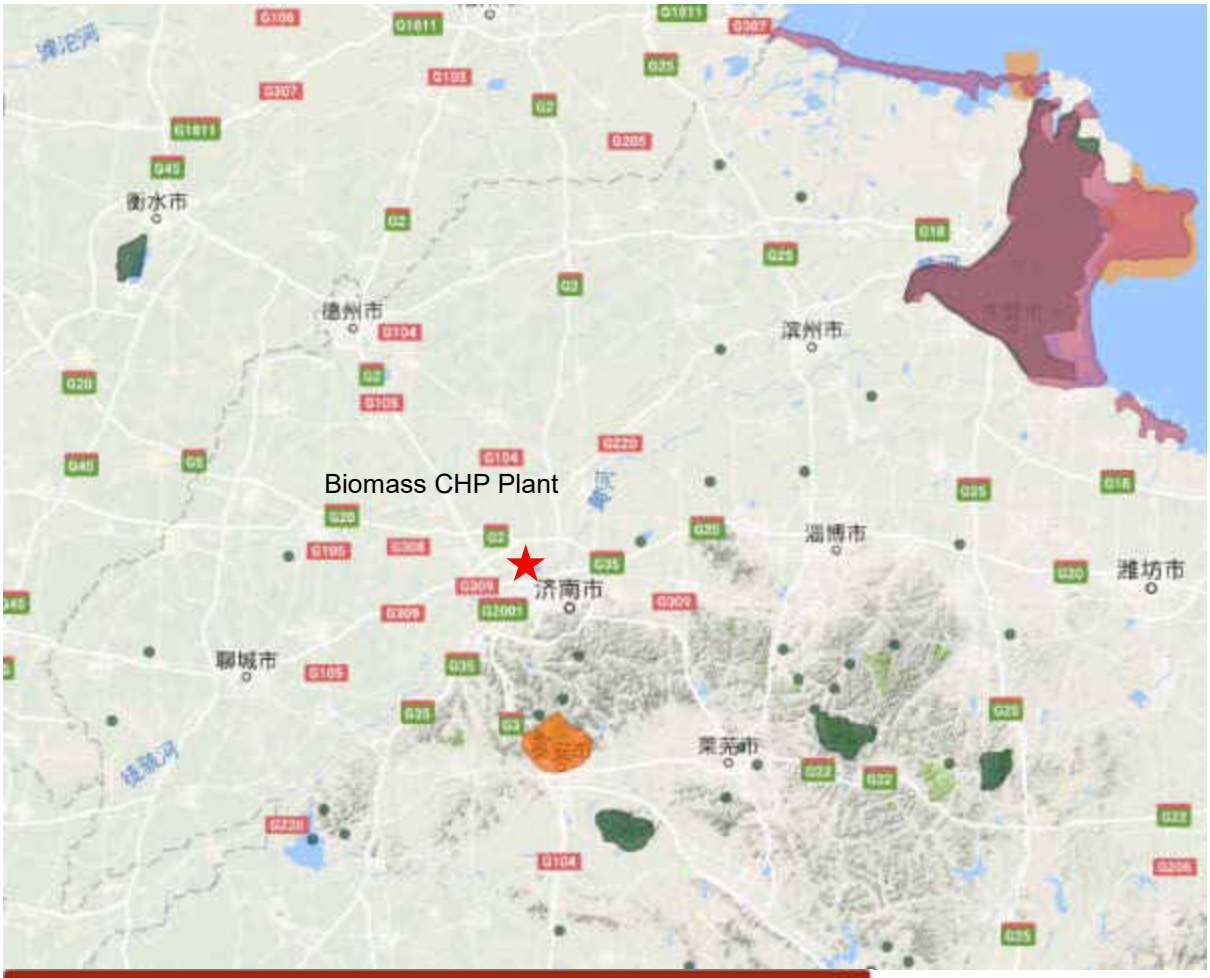
288. The locations of component site have been reviewed against provincial records provided by the IBAT[17] maps of Shandong protected areas and Important Bird and Biodiversity Areas (IBBAs). No component encroaches on any legally protected natural area or other critical habitats.

289. 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 (**Table III-21**) 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.

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

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

Figure V-2: IBAT Habitat Areas and Component location



Map Layers

Protected areas: national-level

- ☐ IUCN management categories Ia, Ib, II
- ☑ IUCN management categories III, IV
- ☑ IUCN management categories V, VI
- ☐ IUCN management categories not reported/not assigned

Protected areas: regional

- ☑ Natura 2000
- ☑ Regional Seas

Protected areas: international

- ☑ Natural/Mixed World Heritage sites
- ☑ Ramsar sites
- ☑ UNESCO Man and the Biosphere Reserves

Priority sites for biodiversity

- ☐ Key Biodiversity Areas
- ☑ Important Bird & Biodiversity Areas
- ☑ Alliance for Zero Extinction Sites

Species

- ☐ Species Grid
- ☐ Freshwater Biodiversity

Regions of conservation importance

- ☑ Endemic Bird Areas
- ☑ Biodiversity Hotspots
- ☑ High Biodiversity Wilderness Areas

Completeness

- ☐ KBA Completeness

2. Erosion and Spoil

291. Construction activities such as land leveling, excavation and filling activities 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.

292. 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).

(xii) Based on site visit, the spoil disposal site is closed to the component site at the north direction. Conduct component completion audit to confirm that spoil disposal site rehabilitation meets required standard, hold contractor liable in case of noncompliance.

3. Wastewater

293. 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.

294. Construction wastewater will be produced from the maintenance and cleaning of mechanical equipment and vehicles, maintenance water for mixing and curing concrete, cooling water, and lost water and soil during the construction period which is discharged as pollutants. 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.

295. Inappropriate disposal of construction wastewater (from construction site runoff, drainage of drilling, washing construction equipment and vehicles, pouring and curing concrete, 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.

296. 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) Worker camp will be installed with sufficient toilets (based on the staff numbers, 4 toilets are sufficient) which will be provided for the workers and will be cleaned and discharged to the municipal sewerage system on a regular basis. Once the construction starts, if it is found that 4 toilets are not enough or there are female workers, more toilets will be provided.

(ii) Construction wastewater will be directed to temporary detention and settling ponds, and then treated water will be partly recycled for use in dust control and the rest of treated water will be discharged to the local municipal sewer system and the waste residue in the tank is cleared and transported to designated certificated and engineered landfills by the local sanitation department personnel. If needed, polyacrylamide flocculent will be used to facilitate particle settling. All discharged construction wastewater will to be treated to meet the appropriate PRC standard GB/T 31962-2015 prior to discharge. Discharged water will then be treated in the WWTP of JNMIP.

(iii) All necessary measures will be undertaken to prevent construction materials and waste from entering drains and water bodies.

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

(v) Oil traps are provided for service areas and parking areas, and oil-water separators are installed before the sedimentation tank for oil-containing wastewater;

(vi) 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;

(vii) 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;

(viii) 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);

(ix) Drilling equipment will be cleaned up before drilling to prevent ground water pollution.

(x) Drilling water will be reused as much as possible during drilling. Waste water generated during drilling activities will be collected and toxicity assessment will be conducted. Cuttings will be reused if they are non-toxic (e.g. as construction fill) or disposed of in a landfill facility and wastewater will be discharged to municipal sewer system. If toxicity is found, cutting and wastewater will be transported for treatment by a certified company.

4. Air Pollution

297. 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.

298. Fugitive dust will be generated on construction sites during earthworks 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. The EIA predicts unmitigated compliance with the Ambient Air Quality Standard (GB3095-1996) at 150 m downwind of TSP generating activities or locations. With mitigation measures such as frequent watering of unpaved areas and haul roads (7–8 times each day), the EIA estimates that the amount of dust could be reduced by 70% or more and the impact area be reduced to within 100 m downwind of earthwork activities. 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.

299. 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.

300. Without appropriate mitigations, construction phase activities may generate significant localized total suspended particulate (TSP)[18] levels, with worst case conditions occurring in clear weather without watering.

301. 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.

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

(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.

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

(viii) Temporary fencing will be erected around dusty activities.

(ix) Construction spoil, aggregate 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. Powdered materials such as cement and lime will be stored in sealed bags or containers.

(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) Drilling sites will be fenced during drilling. Fence will be installed at site boundaries and dust monitoring will be implemented at Zhouyan Village to ensure compliance.

(xiii) Disturbed site will be revegetated as soon as possible after the completion of works.

302. 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

303. 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.

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

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

305. Based on the above formulas, the noise level at Zhouyan Village will be reduced by 40 dB without any fence. 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-1**. Though noise levels may be high, the impacts will be temporary and localized, and can be further mitigated. Noise fence will be installed during construction to mitigate noise impacts.

Table V-1: Primary noise sources at each construction stage

Construction Phase	No	Name	Sound Level dB(A)	Distance from the source (m)	Noise level at the Zhouyan Village without/with fence	Directivity
Earthwork	1.1	Excavator	80-85	5	40-45/30-35	No
	1.2	Loader	85-90	5	45-50/35-40	No
	1.3	Bulldozer	85-90	3	45-50/35-40	No
	1.4	Dump truck	85-90	3	45-50/35-40	No
Foundation Construction	2.1	Pile equipment	95-105	15	55-65/45-55	No
	2.2	Land leveler	85-90	15	45-50/35-40	No
	2.3	Crane	70-75	15	30-35/20-25	No
	2.4	Truck crane	70-75	15	30-35/20-25	No
Structure Construction	3.1	Concrete pump truck	90-93	4	50-53/40-43	No
	3.2	Concrete transport vehicle	90-93	4	50-53/40-43	No
	3.3	Vibrator	85-90	3	45-50/35-40	No
Final Finishing	4.1	Electrical drill	85-95	5	45-55/35-40	No
	4.2	Electrical hammer	90-95	5	50-55/40-45	No
	4.3	Electrical saw	90-95	5	50-55/40-45	No
Transport Vehicle	5.1	Trailer	70-75	5	30-35/20-25	No
	5.2	Flat car	70-75	5	30-35/20-25	No
	5.3	Truck	70-75	5	30-35/20-25	No

Source: Domestic EIA.

306. 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) Drilling site will be enclosed by fence to reduce noise, if necessary

(x) 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

307. 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 installation and cleaning. An estimated of 0.5 kg/day per worker of domestic waste will be generated from construction workers. Inappropriate waste storage and disposal could affect soil, groundwater, and surface water resources, and hence, public health and sanitation.

308. 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 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.

(v) Construction waste dumpsters will be provided at all work 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) Cuttings are typically reused if they are non-toxic (e.g. as construction fill) or disposed of in a certified and engineered landfill facility.

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

7. Hazardous and Polluting Materials

309. Inappropriate transportation, storage, use and spills of petroleum products 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

310. Component 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 including drilling sites for geothermal deep-well will be made secure, discouraging access by members of the public through appropriate fencing whenever appropriate.

(iv) Emergency response system and health and safety protocols will be developed by the IA before construction of geothermal wells. If the concentration of H_2S is high, the geothermal well will be shut down.

9. Workers Occupational Health and Safety

311. 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.

312. 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 heat working environments in compliance with PRC occupational exposure limits for hazardous agents in work place Part 2: physical agents (GBZ 2.2-2007) and World Bank EHS Guidelines.

(vii) Ensure regular safety meetings with staff.

(viii) H_2S monitoring and warning systems will be installed. If the H_2S level is over 5 ppm, the well shall be sealed and shut-down.

(ix) Electrical safety risks especially related to existing power transmission line following World Bank EHS Guidelines for Electric Power Transmission and Distribution and drilling activities will be assessed and safety protocols will be developed following EHS Guidelines for Geothermal Power Generation.

10. Physical Culture Resources

313. 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

314. The component may cause some adverse impacts during operation including air pollution from biomass combustion, noise, use of water, production of wastewater and solid wastes, fire and safety hazards, and community health and safety.

1. Air Pollution

315. The primary air emission is the exhaust gas from biomass boiler combustion. To minimize emissions and associated impacts, the component will use low NOx biomass boiler with design emission levels in compliance with the most stringent PRC national standard (see **Table II-6**).

316. Biomass generally produces less quantities of PM, SO_2 and NOx compared to plants using coal (without emission reduction measures). When compared to the equivalent production of heat and power through traditional coal-fired sources, once operational the component will: (i) result in annual energy savings equivalent to 63,374.4 tce, thereby providing a global public good by avoiding the annual emission of 168,524.25 tons of CO_2; (ii) improve local air quality through the estimated annual reduction of emissions of SO_2 by 87.86 tons, NOx by 39.85 tons, and PM by 7.02 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.

a. Atmospheric Dispersion Modelling

317. Atmospheric dispersion modelling was undertaken by EIA Institute utilizing AERMOD, a US EPA and PRC approved steady-state short range (up to 50 km) plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of all point, surface and body sources.[19] AERMOD can simulate the concentration distribution in both the short term (1-hour and daily average concentrations) and the long term (annual average concentrations). AERMOD is applicable for rural or urban districts and simple or complicated terrain. The impact of bottom flow of buildings (e.g. plume downwash) is also taken into account. AERMOD uses meteorological data for 1-hour continuous pre-

[19] AERMOD is recommended model in Appendix A of Guidelines for Environmental Impact Assessment of Atmospheric Environment (HJ2.2-2008).

treatment to simulate average concentration distribution in periods down to 1 hour. AERMOD includes two preprocessors: AERMET, which accepts surface meteorological data and upper air soundings, and then calculates atmospheric parameters needed by the dispersion model; and AERMAP, a terrain preprocessor which provide a physical relationship between terrain features and the behavior of air pollution plumes. It generates location and height data for each receptor location. It also provides information that allows the dispersion model to simulate the effects of air flowing over hills or splitting to flow around hills.

318. Ground characteristic parameters required by AERMOD (surface albedo at high noon, Bowen at daytime and ground roughness) were set according to recommended parameters in the reference model suitable for the component area. Atmospheric diffusion parameters mainly use ground meteorological data and sounding meteorological data to generate the predicted meteorological input document.

b. Meteorological Data

319. Climate data from 1997-2016 and daily and hourly conventional meteorological data for 2016 was obtained from the Qihe meteorological station to provide meteorological data for the atmospheric dispersion modeling. The Qihe meteorological station is located at 36°47′48″N and 116°45′48″E and is about 22 km away from the biomass CHP plant.

320. The modeling utilized one year of 8,784 hourly and 366 daily meteorological data for 2016, including hourly wind directions and wind speed for each day, dry-bulb temperature, ground data like cloud cover (total cloud cover and low cloud cover), etc. Daily high altitude data was extrapolated in AERMET from two times per day every 100 m from 0-3000 m. The AERMET estimate method was used for mixed layer height. The default of 200 calculated layers was utilized with a maximum altitude of 5000 m.

321. From 1997 to 2016, maximum wind speed of Qihe is 12.9 m/s, extreme high temperature is 41.8°C and extreme low temperature is -17.5°C, maximum annual precipitation is 928.6 mm in 2009. **Table V-2** presents summary data obtained for the period 1996-2016 from the Qihe meteorological station.

Table V-2: Summary of Qihe meteorological data, 1997-2016

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed (m/s)	1.9	2.2	2.7	2.6	2.1	1.9	1.5	1.4	1.4	1.6	1.9	1.8
Temperature (°C)	-1.9	1.9	8.0	15.0	20.8	25.7	27.2	25.6	20.9	14.9	6.8	0.2
Relative humidity (%)	60	58	56	60	65	64	79	83	77	70	67	66
Precipitation (mm)	3.5	7.9	12.8	33.1	56.6	79.9	180.0	165.3	57.6	32.6	12.3	3.9
Sunshine duration (hour)	160.5	151.0	202.0	222.0	237.9	206.5	177.7	175.1	166.5	171.6	160.2	146.5

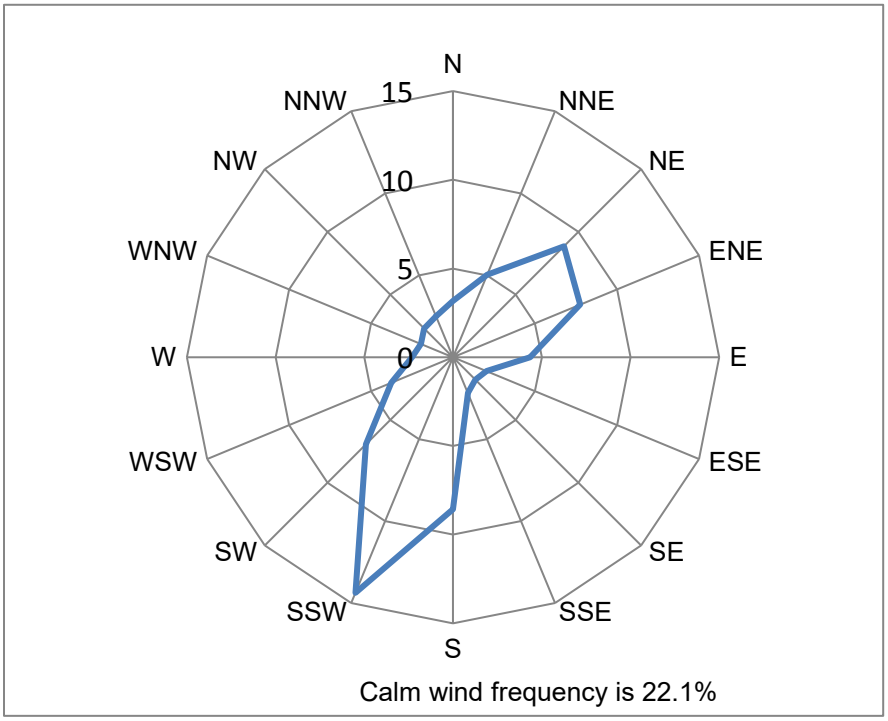
322. Wind direction frequency of Qihe meteorological station from 1997 to 2016 is presented in **Table V-3**.

Table V-3: Summary Qihe wind direction frequency data, 1997-2016.

Wind direction	N	NNE	NE	ENE	E	ESE
Frequency	3.2	5.0	8.8	7.8	4.3	2.0
Wind direction	SE	SSE	S	SSW	SW	WSW
Frequency	1.8	2.2	8.6	14.4	6.9	3.8
Wind direction	W	WNW	NW	NNW	Calm wind	
Frequency	2.3	1.9	2.3	2.5	22.1	

323. Wind rose of Qihe from 1997 to 2016 is presented in **Figure V-2**. Figure V-2 is wind rose from 1997-2016, while Figure V-3 and Figure IV-6 is the wind rose in 2016.

Figure V-3: Qihe wind roses, based on data from 1997-2016



324. Conventional meteorological data the Qihe meteorological station for 2016 was obtained. Monthly average temperature and wind speed of Qihe are presented in **Table V-4**. Monthly average wind speeds in four seasons are presented in **Table V-5**

Table V-4: Monthly average temperature of Qihe, 2016

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed (m/s)	2.19	2.00	2.91	2.31	3.18	1.89	2.04	1.55	1.47	2.20	1.65	1.94
Temperature (°C)	3.14	2.11	12.57	17.18	24.11	25.02	27.09	25.40	21.23	16.74	8.78	1.66

Table V-5: Monthly average wind speeds in four seasons of Qihe, 2016 Unit: m/s

Season	2 am	8 am	2 pm	8 pm
Spring	2.54	2.49	3.40	2.34
Summer	1.57	1.36	2.24	2.01
Autumn	1.69	1.47	1.97	1.67
Winter	2.10	1.80	2.37	1.82

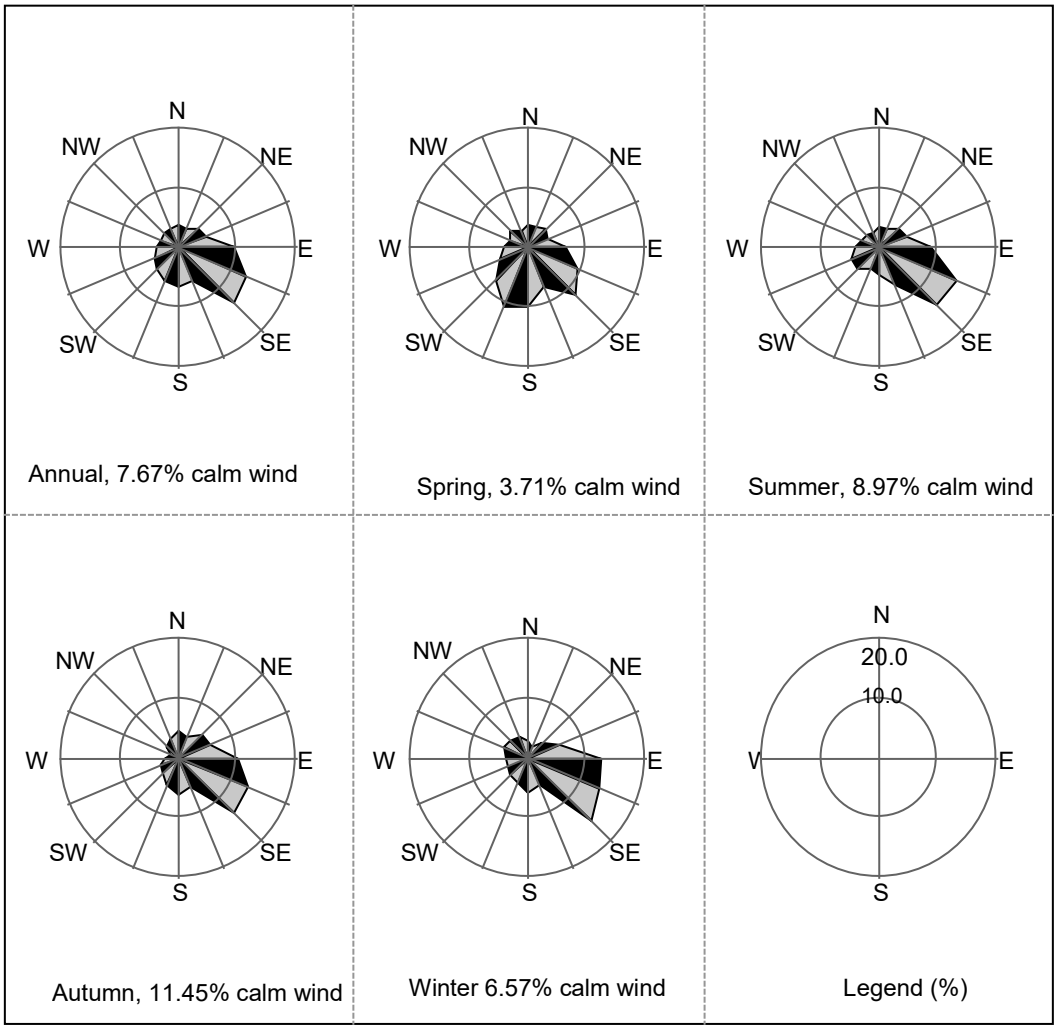
325. Wind direction frequency of Qihe in 2016 is presented in **Table V-6**.

326. Wind roses of Qihe in 2016 are presented in **Figure V-3**.

Table V-6: Wind direction frequency of Qihe, 2016

Wind direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Calm
Jan	2.42	2.28	4.17	5.78	9.81	12.37	14.65	6.05	9.54	6.45	4.17	4.03	2.96	1.88	3.49	3.49	6.45
Feb	2.83	1.49	4.32	9.67	23.36	15.03	11.01	3.13	3.13	1.49	2.68	3.42	2.08	3.57	2.53	2.98	7.29
Mar	3.09	3.63	3.23	4.44	7.53	11.96	12.10	5.51	11.56	11.96	6.85	4.17	3.09	2.82	3.76	2.28	2.02
Apr	5.42	7.22	7.22	4.72	8.19	7.64	11.53	3.61	7.08	6.39	7.22	4.72	3.61	2.78	2.64	4.31	5.69
May	2.82	0.54	2.69	1.88	3.49	7.12	9.81	11.42	10.35	13.17	9.01	6.59	5.24	3.90	5.91	2.55	3.49
Jun	4.44	5.97	4.86	4.72	10.97	14.03	9.44	5.56	2.78	2.08	4.72	6.53	4.72	3.19	3.06	3.19	9.72
Jul	1.88	3.36	4.70	4.17	5.91	12.77	13.98	8.74	7.12	6.32	7.26	5.51	3.63	2.96	2.02	1.88	7.80
Aug	4.44	0.81	4.44	6.59	9.41	15.73	17.07	5.78	3.49	2.69	3.36	3.23	3.63	3.36	3.49	3.09	9.41
Sep	5.69	4.44	7.36	6.67	10.97	10.69	13.19	5.42	3.75	2.36	2.08	3.33	1.53	1.39	1.67	3.75	15.69
Oct	3.09	3.23	4.84	6.72	10.89	12.50	11.29	5.78	8.20	7.26	4.30	3.23	3.23	1.75	2.55	1.88	9.27
Nov	4.31	3.89	4.44	3.89	7.78	14.58	14.72	4.17	6.25	5.00	4.72	3.61	2.64	1.67	4.03	4.86	9.44
Dec	3.63	2.42	1.61	2.69	4.57	12.10	18.68	5.51	4.44	4.84	5.11	3.76	5.65	7.80	6.32	4.84	6.05
Spring	3.76	3.76	4.35	3.67	6.39	8.92	11.14	6.88	9.69	10.55	7.70	5.16	3.99	3.17	4.12	3.03	3.71
Summer	3.58	3.35	4.66	5.16	8.74	14.18	13.54	6.70	4.48	3.71	5.12	5.07	3.99	3.17	2.85	2.72	8.97
Autumn	4.35	3.85	5.54	5.77	9.89	12.59	13.05	5.13	6.09	4.90	3.71	3.39	2.47	1.60	2.75	3.48	11.45
Winter	2.96	2.08	3.33	5.93	12.22	13.10	14.91	4.95	5.79	4.35	4.03	3.75	3.61	4.44	4.17	3.80	6.57
Annual	3.66	3.26	4.47	5.13	9.29	12.19	13.15	5.92	6.52	5.89	5.15	4.35	3.52	3.09	3.47	3.25	7.67

Figure V-4: Qihe wind roses, 2016



c. Atmospheric Dispersion Model Scenarios

327. Atmospheric Dispersion Modelling Scenarios of the component are presented below:

(i) Scenario 1: Worst case SO_2, PM_{10} and NO_2 ground level concentrations (GLCs) over the entire 2016 modelling period (8640h) with both boilers running simultaneously, including:

(a) Worst case predicted 1-hour averaging period SO_2, NO_2 and ammonia GLCs;

(b) Worst case predicted 24-hour averaging period SO2, PM2.5, PM10 and NO2 GLCs;

(c) Worst case predicted annual averaging period SO2, PM2.5, PM10 and NO2 GLCs.

(ii) Scenario 2: Worst case SO_2, PM_{10} and NO_2 ground level concentrations (GLCs) over the entire 2016 modelling period (8640h) with both boilers running simultaneously, superimposed over worst case background ambient air quality monitoring data, including[20]:

(a) Worst case predicted 1-hour averaging period SO_2, PM_{10} and NO_2 GLCs + worst case ambient concentration at monitoring sites.

(b) Worst case predicted 24-hour averaging period SO_2, PM_{10} and NO_2 GLCs + worst case ambient concentration at monitoring sites.

(c) Worst case predicted annual averaging period SO_2, PM_{10} and NO_2 GLCs + worst case ambient concentration at monitoring sites.

d. Atmospheric Dispersion Model Input

328. The emission parameters of the component are presented in **Table V-7**.

Table V-7: Parameter of dispersion modelling

Item	Source type	Emission rate (kg/h)	Stack height (m)	Inner diameter at the outlet (m)	Exhaust gas flow at the outlet (m^3/s)	Exhaust gas temperature at the outlet (K)	Ambient temperature at the outlet (K)	Ambient environment
SO_2	Point	8.22	100	3	49.42	353	287.8	Rural
NO_X	Point	17.8				353	287.8	Rural
PM_{10}	Point	2.72				353	287.8	Rural
$PM_{2.5}$	Point	1.36				353	287.8	Rural
Ammonia	Point	0.142				353	287.8	Rural

Note: To get worse case GLCs of different pollutants, maximum pollutants emission rate in **Table III-14** is utilized.

Source: Domestic EIA.

e. Receptor Grid System

329. Predictions of concentration were made for a 10,000 × 10,000 m grid (**Figure V-4**). The grid consists of 100 m x 100 m cells with a total of 10,000 receptors. The grid origin coordinates (0,0) is 116°54′47.25″E and 36°48′25.78″N. Map projection is UTM and geodetic datum is WGS84. Terrain was assumed to be flat.

[20] The average annual concentrations in Jinan in 2017 were used as annual baseline concentrations.

Figure V-5: 10 km x 10 km AERMOD modelling grid

Note: Red points are nearby sensitive receptors.
Source: Domestic EIA.

330. Sensitive receptors within the influence area are listed in **Table V-8**.

Table V-8: Model Input Data for Sensitive receptors

No.	Location	Direction	Distance (m)	X (m)	Y (m)	Ground elevation
1	Gaowang Village	NE	2000	2392	1537	24.52
2	Beiwangtang Village	NNW	1100	-223	1307	24.06
3	Caomiaowang Village	WSW	1200	-1046	-466	26.25
4	Tianjia Village	SW	2500	-2098	-1869	26.65
5	Beidong Village	S	440	466	-695	26.7
6	Huaizhuang Village	SSE	1600	848	-1754	26.4
7	Zhouyan Village	W	100	-96.5	0	25.84

Source: Domestic EIA (2018).

f. Meteorological Data

331. Climate data from 1996-2016 and daily and hourly conventional meteorological data in

2016 was obtained from the Qihe meteorological station to provide meteorological data for atmospheric dispersion modeling. The Qihe meteorological station is located at 36°36′11.68″N and 117°00 ′24.74″E and is 24 km from the plant.

332. The modeling utilized one year of hourly and daily meteorological data for the year 2016, including hourly wind directions and wind speed for each day in 2016, dry-bulb temperature, ground data like cloud cover (total cloud cover and low cloud cover), etc. Daily high altitude data was extrapolated in AERMET from two times per day every 100 m from 0 -3000 m. The missed layer heights were calculated using AERMET's default method. The default of 200 calculated layers was utilized with a maximum altitude of 5000 m.

333. Ground characteristic parameters required by AERMOD (surface albedo at high noon, Bowen at daytime and ground roughness) were set according to recommended parameters in the reference model suitable for the component. Atmospheric diffusion parameters mainly use ground meteorological data and sounding meteorological data to generate the predicted meteorological input document.

g. Scenario 1 Result

334. The Scenario 1 ten worst case SO_2 GLCs and corresponding date and position are presented in **Table V-9**, **Figure V-5**, **Figure V-6** and **Figure V-7**.

335. The modelling shows that, under the meteorological conditions of 2016, the worst case 1-hour average GLC of SO_2 from the component is 15.1 μg/m³, equivalent to 3.02% of the PRC standard. The location is (0, -100) and the time is 12 pm of December 9. The worst case 24-hour average GLC of SO_2 from the component is 0.967 μg/m³ equivalent to 0.65% of the PRC standard and 4.8% of WHO guideline value (20 μg/m³). The location is (-900, -100) and the time is May 17. The worst case annual average GLC of SO_2 from the component is 0.171 μg/m³ equivalent to 0.285% of the PRC standard. The location is (300,200).

336. Based on the modeling results, these worst case GLCs are only predicted to occur one time in the modeling year (2016).

Table V-9: Scenario 1 ten worst case SO_2 GLCs and corresponding date and positions (mg/m³)

No.	1-hour average concentration				24-hour average concentration				Annual average concentration		
	X	Y	Time	Value	X	Y	Time	Value	X	Y	Value
1	0	-100	16120912	1.51E-02	-900	-100	160517	9.67E-04	300	200	1.71E-04
2	0	-100	16030910	1.34E-02	-850	-100	160517	9.65E-04	250	150	1.71E-04
3	-50	-150	16030910	1.20E-02	-850	-50	160517	9.61E-04	300	150	1.70E-04
4	2200	-50	16011815	5.58E-03	-950	-100	160517	9.61E-04	250	200	1.70E-04
5	2200	0	16011815	5.57E-03	-900	-50	160517	9.54E-04	300	250	1.69E-04

6	2400	-50	16011815	5.57E-03	-800	-50	160517	9.52E-04	250	250	1.68E-04
7	2400	0	16011815	5.55E-03	-1000	-100	160517	9.46E-04	350	200	1.68E-04
8	2200	-100	16011815	5.53E-03	-800	-100	160517	9.43E-04	350	250	1.68E-04
9	2400	-100	16011815	5.52E-03	-950	-50	160517	9.39E-04	250	100	1.68E-04
10	2600	-50	16011815	5.48E-03	-750	-50	160517	9.24E-04	300	100	1.67E-04

Note: For 1-hour average, time is Year/Month/Day/Hour. For 24-hour average, time is Year/Month/Day.

Source: Domestic EIA (2018).

Figure V-6: SO_2 contour map of worst case 1-hour average concentration

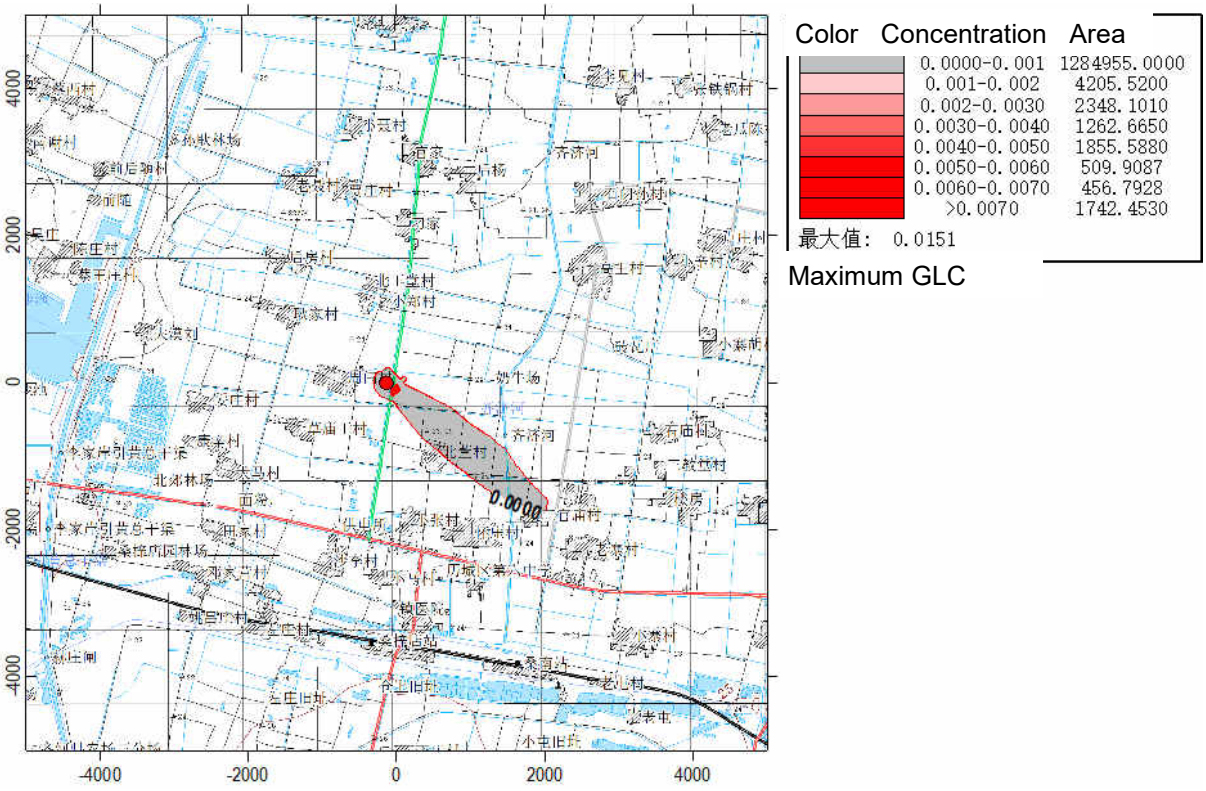


Figure V-7: SO_2 contour map of worst case 24-hour average concentration

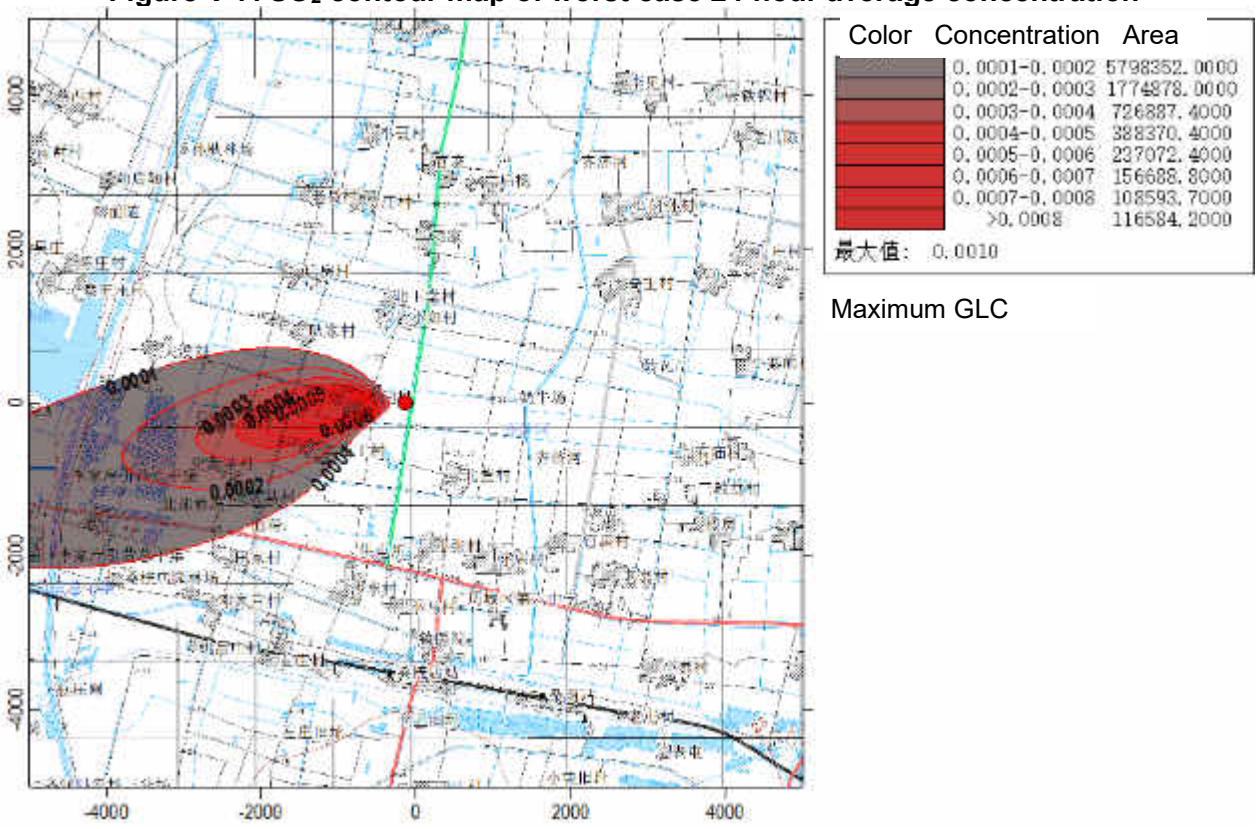
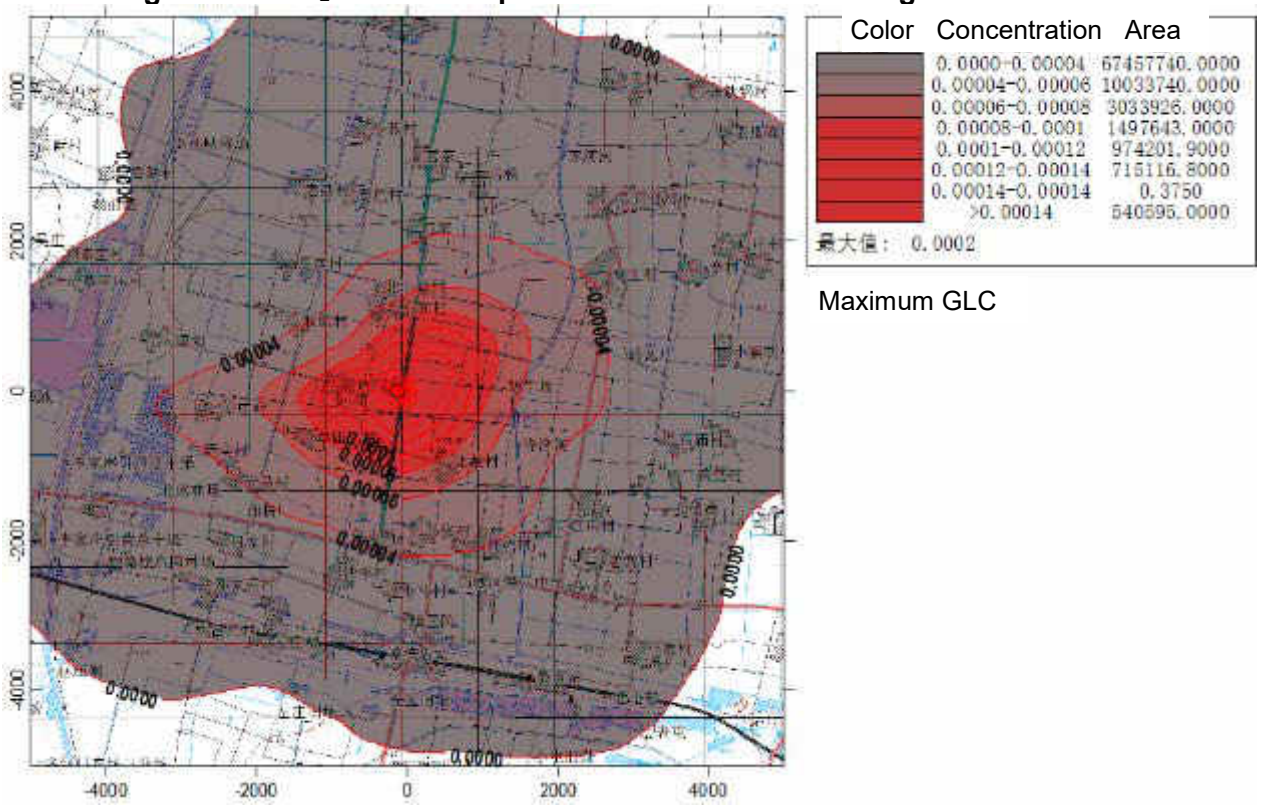


Figure V-8: SO_2 contour map of worst case annual average concentration



337. The Scenario 1 ten worst case NO_2 GLCs and corresponding date and position are presented in **Table V-10**, **Figure V-8**, **Figure V-9** and **Figure V-10**.

338. The modelling shows that, under the meteorological conditions of 2016, the worst case 1-hour average GLC of NO_2 from the component is 10.9 μg/m³ equivalent to 5.5% of the PRC standard 5.45% of WHO Guideline value. The location is (2200, -50) and the time is 3 pm of January 18. The worst case 24-hour average GLC of NO_2 from the component is 1.88 μg/m³ equivalents to 2.35% of the PRC standard. The location is (-900, -100) and the time is May 17. The worst case annual average GLC of NO_2 from the component is 0.332 μg/m³ equivalent to 0.83% of the PRC standard and WHO Guideline value. The location is (300,200).

339. Based on the modeling results, all these worst case GLCs are only predicted to occur one time in the modeling year (2016).

Table V-10: Scenario 1 ten worst case NO_2 GLCs and corresponding date and positions. Unit; mg/m^3

No.	1-hour average concentration				24-hour average concentration				Annual average concentration		
	X	Y	Time	Value	X	Y	Time	Value	X	Y	Value
1	2200	-50	16011815	1.09E-02	-900	-100	160517	1.88E-03	300	200	3.32E-04
2	2200	0	16011815	1.09E-02	-850	-100	160517	1.88E-03	250	150	3.32E-04
3	2400	-50	16011815	1.09E-02	-850	-50	160517	1.87E-03	300	150	3.32E-04
4	2400	0	16011815	1.08E-02	-950	-100	160517	1.87E-03	250	200	3.32E-04
5	0	-100	16030910	1.08E-02	-900	-50	160517	1.86E-03	300	250	3.30E-04
6	2200	-100	16011815	1.08E-02	-800	-50	160517	1.86E-03	250	250	3.28E-04
7	2400	-100	16011815	1.07E-02	-1000	-100	160517	1.84E-03	350	200	3.28E-04
8	0	-100	16120912	1.07E-02	-800	-100	160517	1.84E-03	350	250	3.27E-04
9	2600	-50	16011815	1.07E-02	-950	-50	160517	1.83E-03	250	100	3.27E-04
10	2200	50	16011815	1.06E-02	-750	-50	160517	1.80E-03	300	100	3.26E-04

Note: T For 1-hour average, time is Year/Month/Day/Hour. For 24-hour average, time is Year/Month/Day.
Source: Domestic EIA (2018).

Figure V-9: NO_2 contour map of worst case 1-hour average concentration

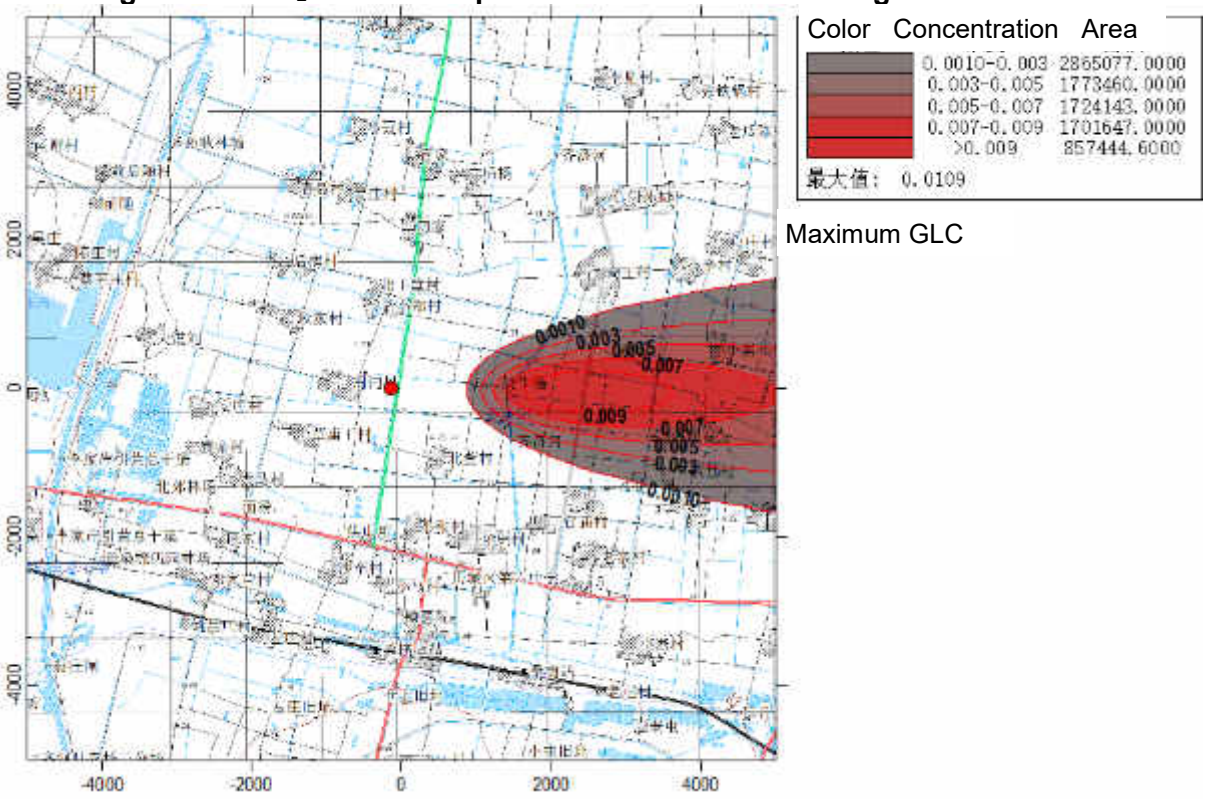


Figure V-10: NO_2 contour map of worst case 24-hour average concentration

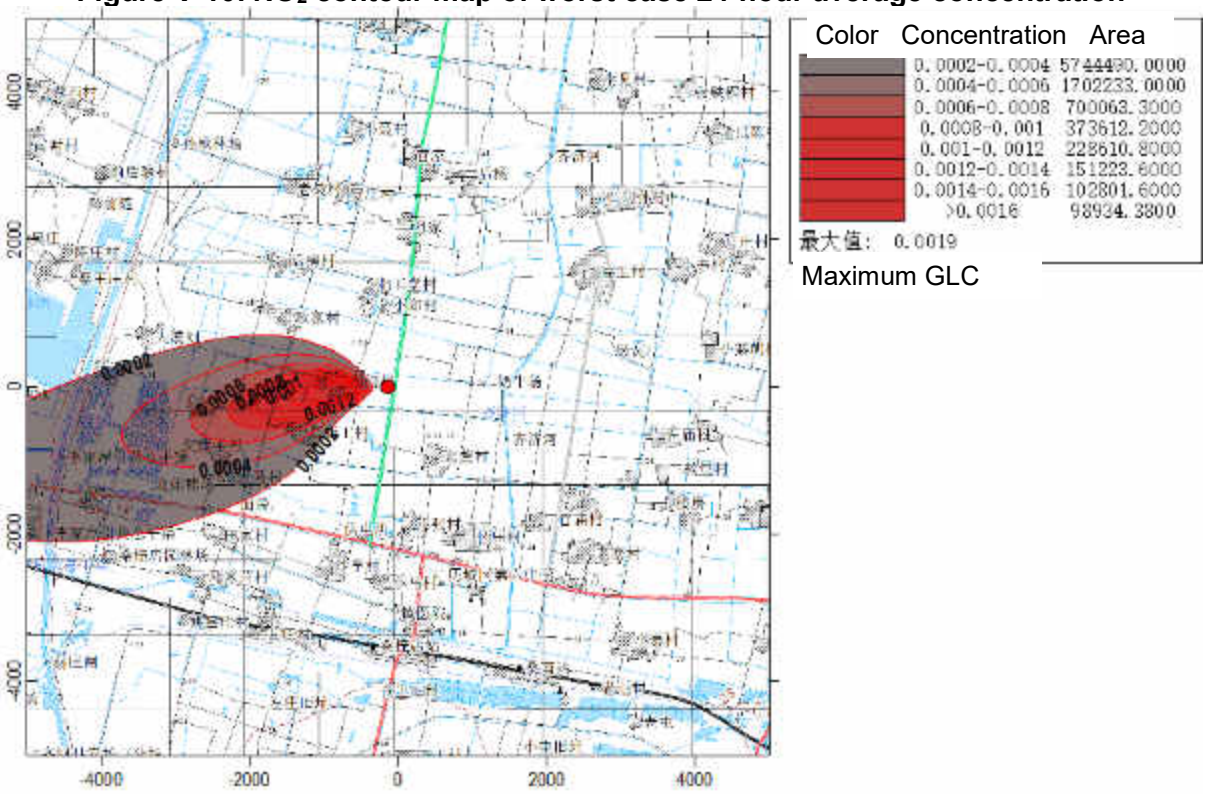
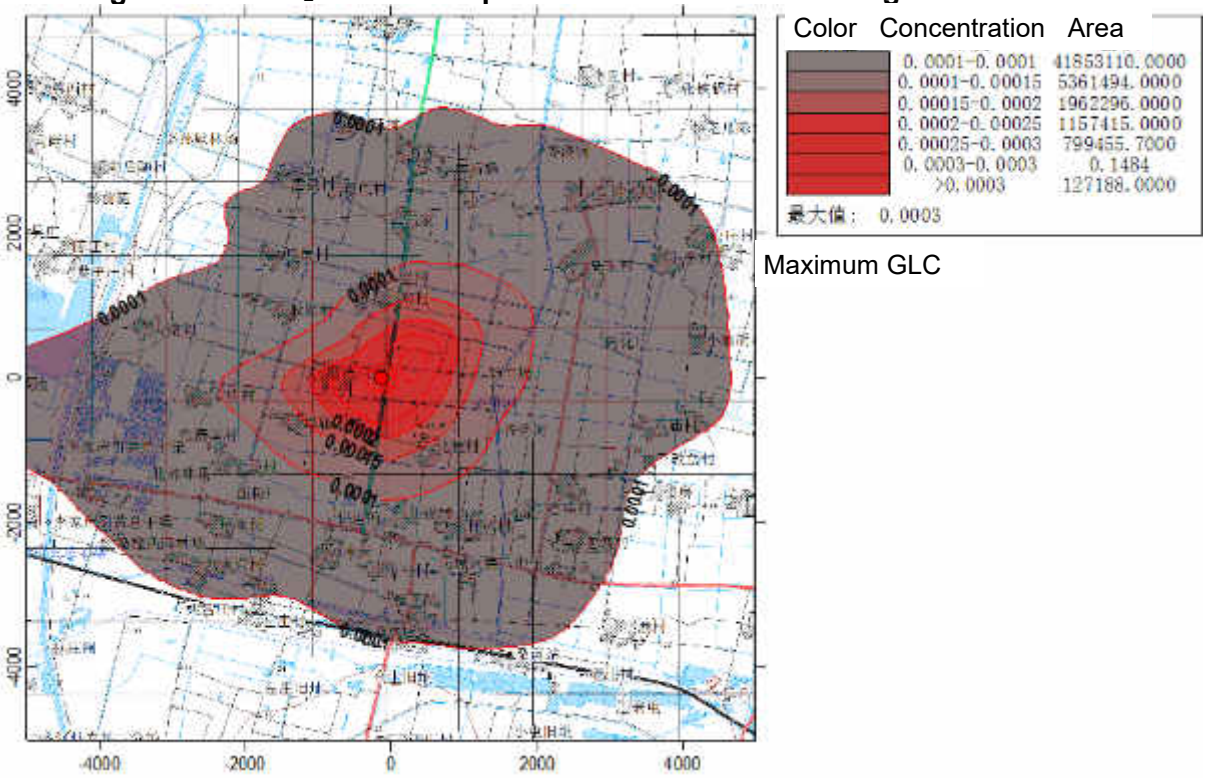


Figure V-11: NO_2 contour map of worst case annual average concentration



340. The Scenario 1 ten worst case PM_{10} GLCs and corresponding date and position are presented in **Table V-11**, **Figure V-11** and **Figure V-12**.

341. The modelling results show that, under the meteorological conditions of 2016, the worst case 24-hour average GLC of PM_{10} from the component is 0.32 μg/m³ equivalents to 0.21% of the PRC standard and 0.64% of WHO Guideline value (50 μg/m³). The location is at coordinate (-900, -100) and the time is 17 May 2016. The worst case annual average GLC of PM_{10} from the component is 0.0565 μg/m³ equivalents to 0.08% of the PRC standard and 0.28% of WHO Guideline value (20 μg/m³). The location is at (300, 200)

342. Based on the modeling results, all these worst case GLCs are only predicted to occur one time in the modeling year (2016).

Table V-11: Scenario 1 ten worst case PM_{10} GLCs and corresponding date and positions. Unit: mg/m^3

No.	1-hour average concentration				24-hour average concentration				Annual average concentration		
	X	Y	Time	Value	X	Y	Time	Value	X	Y	Value
1			NA		-900	-100	160517	3.20E-04	300	200	5.65E-05
2			NA		-850	-100	160517	3.19E-04	250	150	5.64E-05
3			NA		-850	-50	160517	3.18E-04	300	150	5.64E-05
4			NA		-950	-100	160517	3.18E-04	250	200	5.63E-05
5			NA		-900	-50	160517	3.16E-04	300	250	5.61E-05
6			NA		-800	-50	160517	3.15E-04	250	250	5.57E-05
7			NA		-1000	-100	160517	3.13E-04	350	200	5.57E-05
8			NA		-800	-100	160517	3.12E-04	350	250	5.56E-05
9			NA		-950	-50	160517	3.11E-04	250	100	5.55E-05
10			NA		-750	-50	160517	3.06E-04	300	100	5.54E-05

Note: For 1-hour average, time is Year/Month/Day/Hour. For 24-hour average, time is Year/Month/Day.
Source: Domestic EIA (2018).

Figure V-12: PM_{10} contour map of worst case 24-hour average concentration

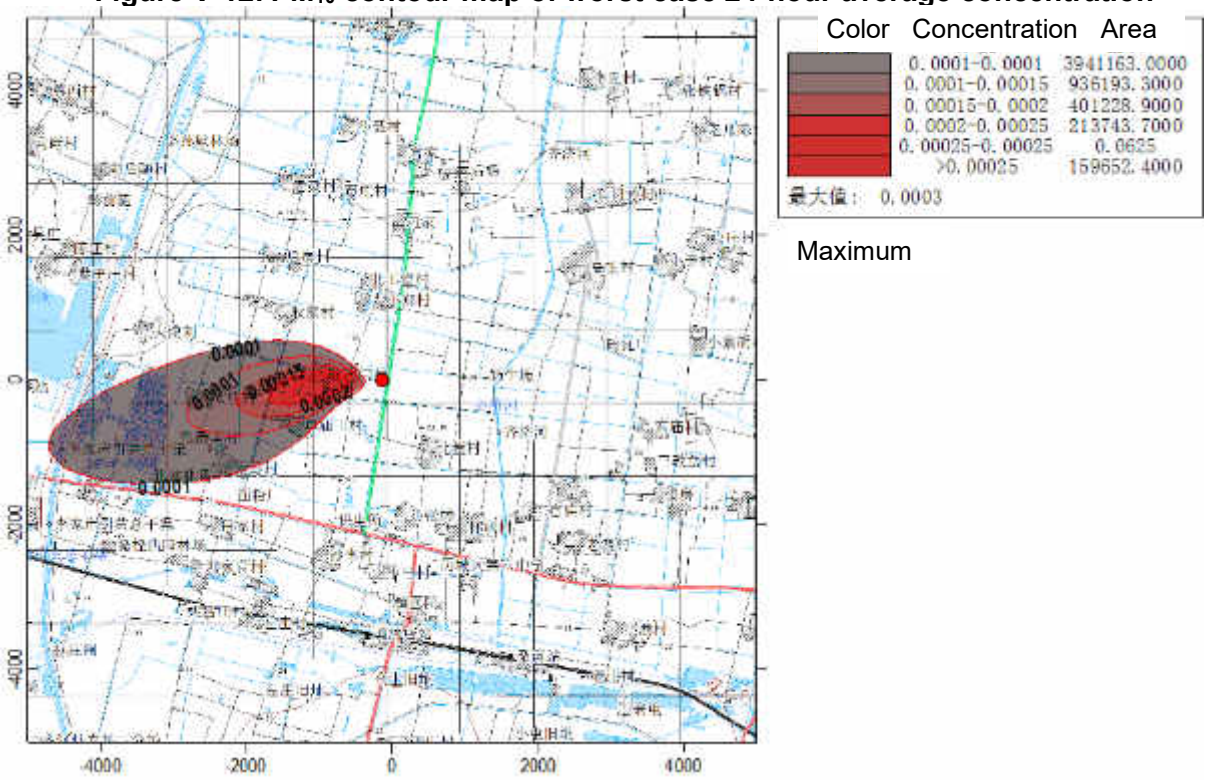
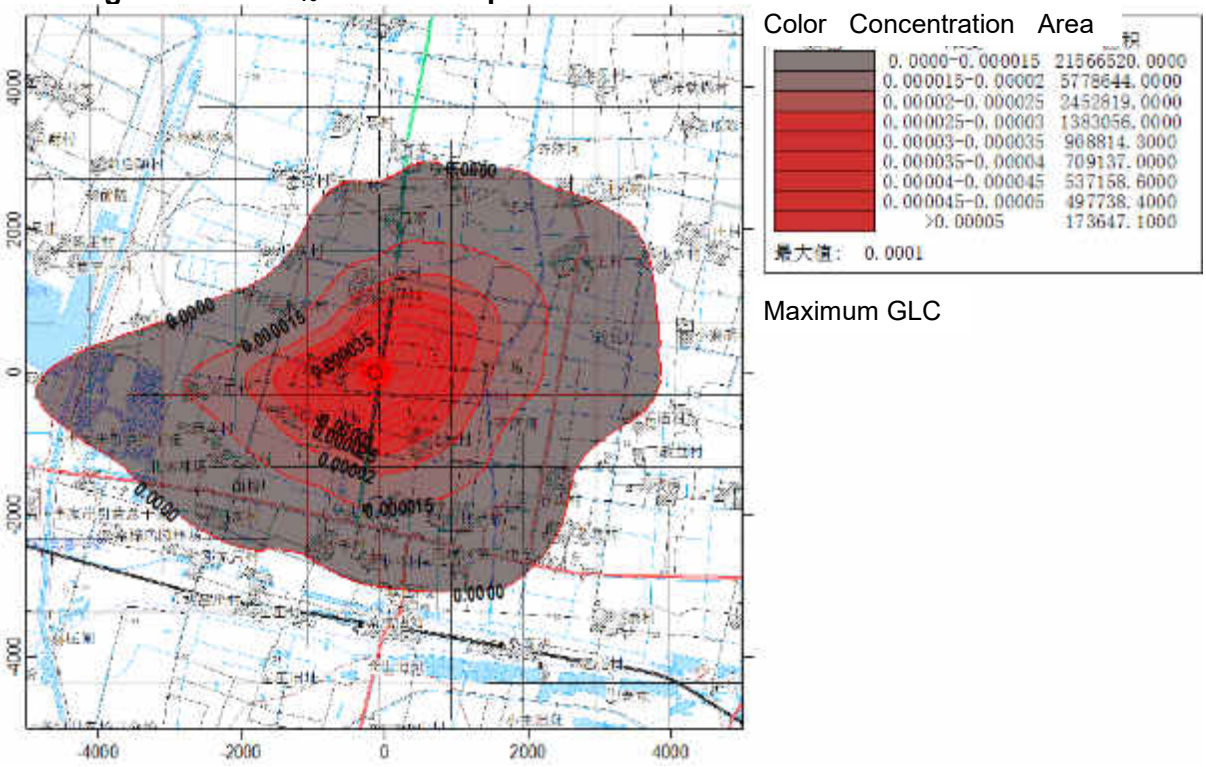


Figure V-13: PM_{10} contour map of worst case annual average concentration



343. The Scenario 1 ten worst cases $PM_{2.5}$ GLCs and corresponding date and position are presented in **Table V-10**, **Figure V-13** and **Figure V-14**.

344. The modelling shows that, under the meteorological conditions of 2016, the worst case 24-hour average GLC of $PM_{2.5}$ from the component is 0.16 μg/m³ equivalent to 0.21% of the PRC standard for $PM_{2.5}$ and 0.64% of WHO Guideline value (25 μg/m³). The location is (-900, -100) and the time is May 17. The worst case annual average GLC of $PM_{2.5}$ from the component is 0.0282 μg/m³ equivalent to 0.08% of the PRC standard and 0.28% of WHO Guideline value (10 μg/m³) . The location is (300,200).

345. These worst case GLCs are predicted to occur one time in the modeling year (2016).

Table V-12: Scenario 1 ten worst case $PM_{2.5}$ GLCs and corresponding date and positions
Unit: mg/m^3

No.	1-hour average concentration				24-hour average concentration				Annual average concentration		
	X	Y	Time	Value	X	Y	Time	Value	X	Y	Value
1			NA		-900	-100	160517	1.60E-04	300	200	2.82E-05
2			NA		-850	-100	160517	1.60E-04	250	150	2.82E-05
3			NA		-850	-50	160517	1.59E-04	300	150	2.82E-05
4			NA		-950	-100	160517	1.59E-04	250	200	2.82E-05
5			NA		-900	-50	160517	1.58E-04	300	250	2.80E-05
6			NA		-800	-50	160517	1.58E-04	250	250	2.79E-05
7			NA		-1000	-100	160517	1.57E-04	350	200	2.78E-05
8			NA		-800	-100	160517	1.56E-04	350	250	2.78E-05
9			NA		-950	-50	160517	1.55E-04	250	100	2.78E-05
10			NA		-750	-50	160517	1.53E-04	300	100	2.77E-05

Note: Time is Year/Month/Day/Hour.
Source: Domestic EIA (2018).

Figure V-14: $PM_{2.5}$ contour map of worst case 24-hour average concentration

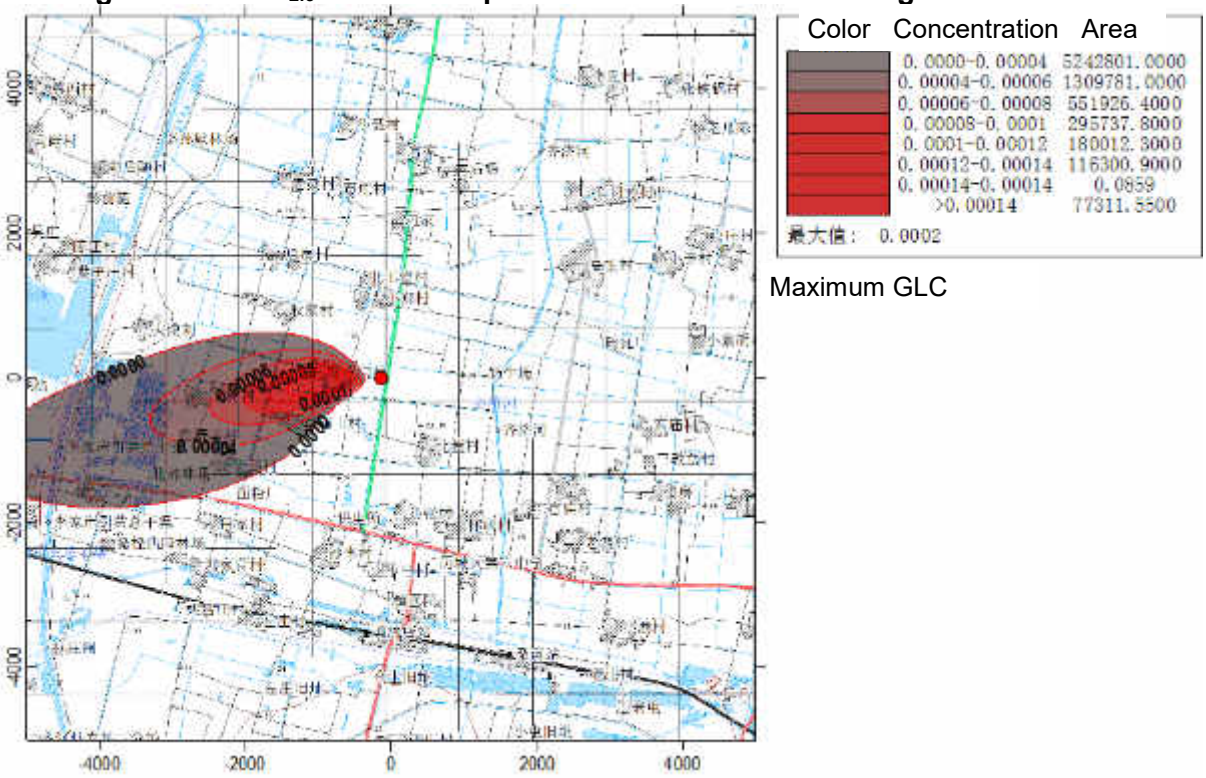
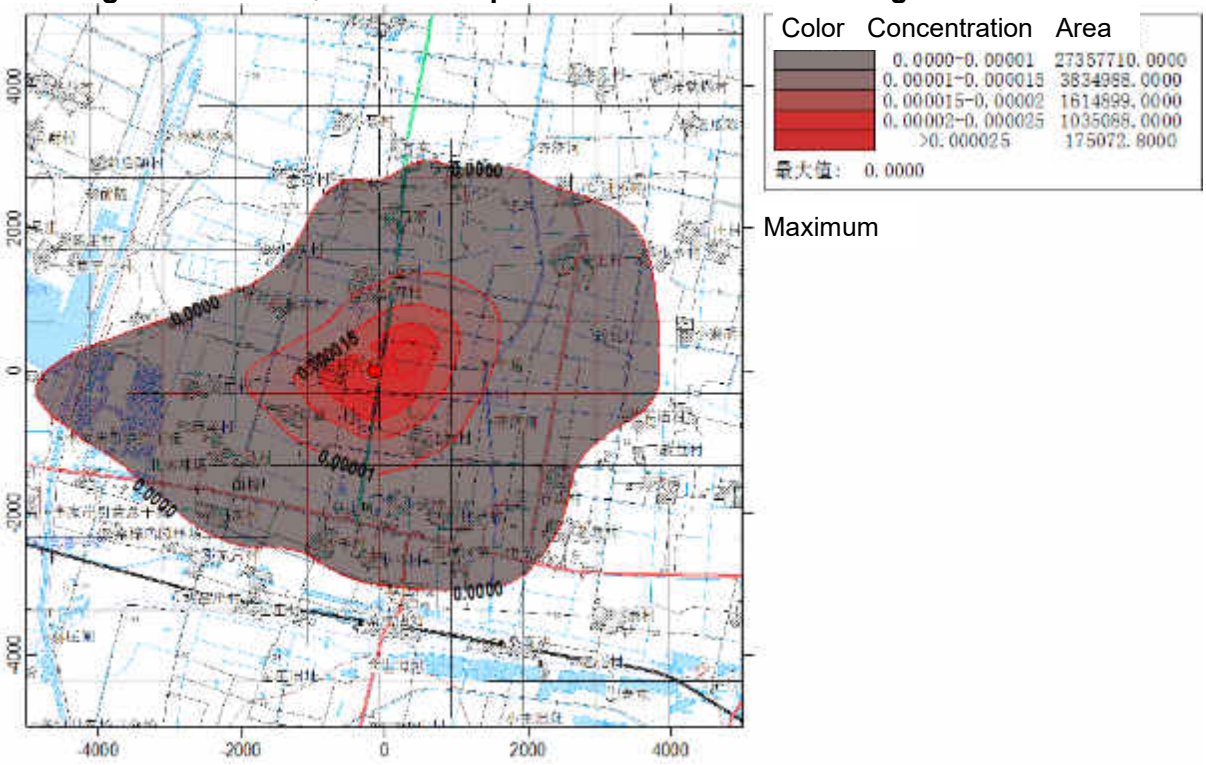


Figure V-15: $PM_{2.5}$ contour map of worst case annual average concentration



346. The Scenario 1 ten worst case NH_3 GLCs and corresponding date and position are

presented in **Figure V-15** and **Table V-13**.

347. The modelling result shows that, under the meteorological conditions of 2016, the worst case 1-hour average GLC of NH_3 from the component is 4.16 μg/m³ equivalents to 0.208 of the PRC standard. The location is (-100, 0) and the time is 11 am of January 11.

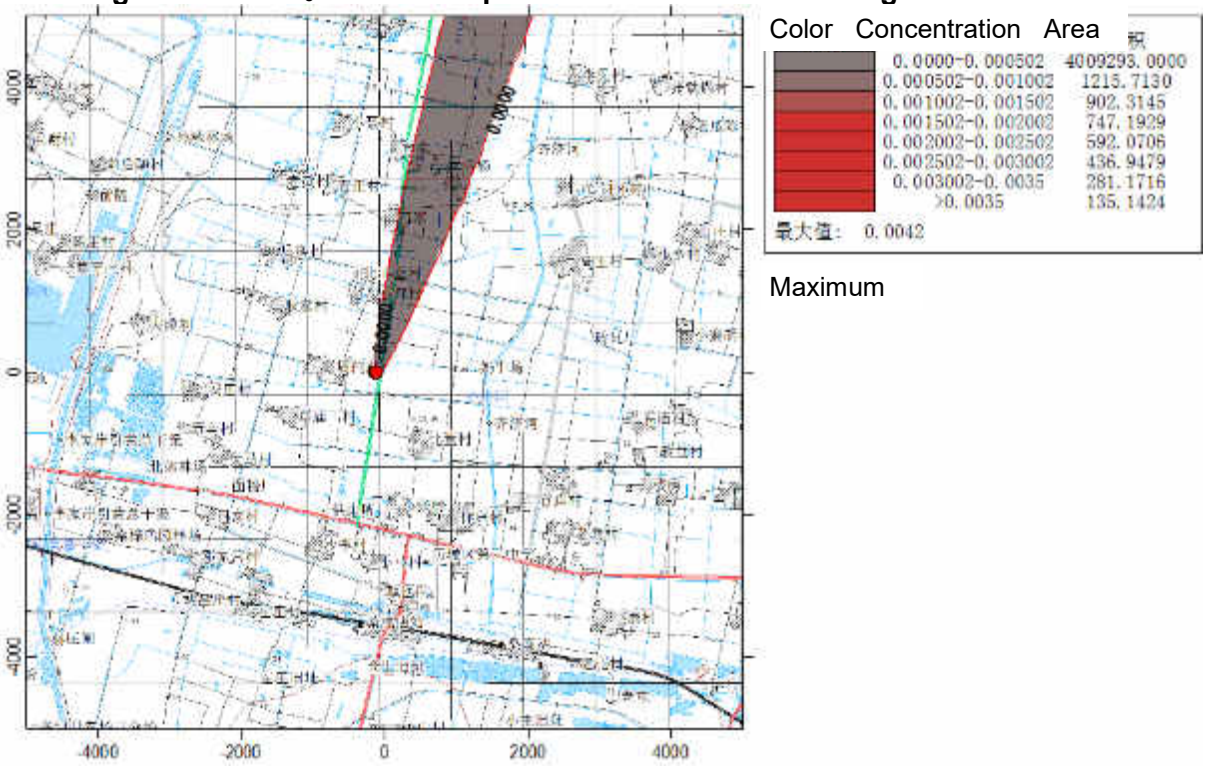
348. These worst case GLCs are predicted to occur one time in the modeling year (2016).

Table V-13: Scenario 1 ten worst case NH_3 GLCs and corresponding date and positions. Unit: mg/m³

No.	1-hour average concentration			
	X	Y	Time	Value
1	-100	0	16011111	4.16E-03
2	-100	-50	16012810	3.72E-03
3	-100	0	16082308	3.64E-03
4	-100	0	16081708	3.62E-03
5	-100	0	16090408	3.51E-03
6	-100	0	16112609	3.45E-03
7	-100	0	16010411	3.38E-03
8	-100	0	16112911	3.33E-03
9	-100	-50	16021310	3.31E-03
10	-100	0	16040209	3.29E-03

Note: Time is Year/Month/Day/Hour.
Source: Domestic EIA (2018).

Figure V-16: NH_3 contour map of worst case 1-hour average concentration



349. The worst case GLCs of Scenario 1 are summarized in **Table V-14**.

Table V-14: Scenario 1 worst case GLCs. Unit: mg/m^3

Emission factor (Max. GLC)		Predicted GLCs			GB3095-2012 / WHO Guidelines
		Concentration	Ratio to national standard (%)	Ratio to WHO Guidelines (%)	
NH_3	1-hour	4.16E-03	0.208	NA	2.0/NA
SO_2	1-hour	1.51E-02	3.02	NA	0.5/NA
	24-hour	9.67E-04	0.645	4.8	0.15/0.020
	Annual	1.71E-04	0.285	NA	0.06/NA
NO_2	1-hour	1.09E-02	5.45	5.45	0.2/0.2
NO_2	1-hour	1.09E-02	5.45	5.45	0.2/0.2
	24-hour	1.88E-03	2.35	NA	0.08/NA
	Annual	3.32E-04	0.83	0.83	0.04/0.04
$PM_{2.5}$	1-hour	NA	NA	NA	NA/NA
	24-hour	1.60E-04	0.213	0.64	0.075/0.025
	Annual	2.82E-05	0.081	0.28	0.035/0.010
PM_{10}	1-hour	NA	NA	NA	NA/NA
	24-hour	3.20E-04	0.213	0.64	0.15/0.050
	Annual	5.65E-05	0.081	0.28	0.07/0.02

h. Scenario 2 Results

350. Scenario 2 modelling results (e.g. worst background concentration value from monitoring in section D of chapter V + worst case concentration predicted GLCs from the component) are presented in **Table V-15**.

351. The modelling shows that, under the meteorological conditions of 2016, the worst case cumulative 1-hour average GLC of SO_2 from the component is 123.1 μg/m³, equivalent to 24.6% of the PRC standard. The location is (0, -100) and the time is 12 pm of December 9. The worst case cumulative 24-hour average GLC of SO_2 from the component is 72.0 μg/m³ equivalent to 48.0% of the PRC standard or 57.6% of WHO IT-1 value. The location is (-900, -100) and the time is May 17. The worst case cumulative annual average GLC of SO_2 from the component is 25.2 μg/m³ equivalent to 42.0% of the PRC standard. The location is (300,200). It can be seen from the modeling results that the component will have negligible impact on air quality. Nevertheless, offsets will be taken by shutting down coal-fired boilers and household stoves for the improvement of air quality in Jinan. 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.

352. The modelling shows that, under the meteorological conditions of 2016, the worst case

cumulative 1-hour average GLC of NO_2 from the component is 77.9 μg/m³ equivalent to 39.0% of PRC standard. The location is (2200, -50) and the time is 3 pm of January 18. The worst case cumulative 24-hour average GLC of NO_2 from the component is 52.9 μg/m³ equivalents to 66.1% of the PRC standard. The location is (-900, -100) and the time is May 17. The worst case cumulative annual average GLC of NO_2 from the component is 46.3 μg/m³ equivalent to 115.8% of the PRC standard. The location is (300,200).

353. The modelling results show that, under the meteorological conditions of 2016, the worst case cumulative 24-hour average GLC of PM_{10} from the component is 209.3 μg/m³ equivalents to 139.5% of the PRC standard and WHO IT-1 value. The location is at coordinate (-900, -100) and the time is 17 May 2016. The worst case cumulative annual average GLC of PM_{10} from the component is 130.1 μg/m³ equivalents to 185.8% of the PRC standard and WHO IT-1 value. The location is at (300, 200).

354. The modelling results show that, under the meteorological conditions of 2016, the worst case cumulative 24-hour average GLC of $PM_{2.5}$ from the component is 125.2 μg/m³ equivalents to 166.9% of the PRC standard and WHO IT-1 value. The location is at coordinate (-900, -100) and the time is 17 May 2016. The worst case cumulative annual average GLC of $PM_{2.5}$ from the component is 63.0 μg/m³ equivalents to 180.1% of the PRC standard and WHO IT-1 value. The location is at (300, 200).

355. The modelling result shows that, under the meteorological conditions of 2016, the worst case cumulative 1-hour average GLC of NH_3 from the component is 164.2 μg/m³ equivalents to 82.1% of the PRC standard. The location is (-100, 0) and the time is 11 am of January 11.

356. The component is in degraded airshed due to non-attainment of SO_2, PM_{10} and $PM_{2.5}$. However, the component will have negligible impacts on air quality since in all cases, short-term GLCs of SO_2, NO_2, $PM_{2.5}$ and PM_{10} are less than 10% of national ambient air quality standards and WHO guideline values and the annual GLCs are less than 1% of national ambient air quality standards and WHO guideline values.

357. Worst case SO_2, NO_2, PM_{10} and $PM_{2.5}$ cumulative (worst case predicted + worst case background) GLCs at monitoring sites (sensitive receptors) are presented in **Table V-16**, **Table V-17**, **Table V-18** and **Table V-19**.

358. The modelling shows that, under the meteorological conditions of 2016, the worst case cumulative 1-hour average GLC of SO_2 at sensitive receptors is 0.109 mg/m^3, equivalent to 22% of standard and occurs in Beiwangtang Village. The worst case cumulative 24-hour average GLC of SO_2 at sensitive receptors is 0.073 mg/m^3, equivalent to 48% of standard and occurs in Beidong Village.

359. The modelling shows that, under the meteorological conditions of 2016, the worst case cumulative 1-hour average GLC of NO_2 at sensitive receptors is 0.074 mg/m^3, equivalent to 37% of standard and occurs in Huaizhuang Village. The worst case cumulative 24-hour average GLC of NO_2 at sensitive receptors is 0.052 mg/m^3, equivalent to 65% of standard and occurs in Beidong Village.

360. The modelling shows that, under the meteorological conditions of 2016, the worst case cumulative 24-hour average GLC of PM_{10} at sensitive receptors is 0.209 mg/m^3, equivalent to 139% of standard and occurs in Beidong Village.

361. The modelling shows that, under the meteorological conditions of 2016, the worst case cumulative 24-hour average GLC of $PM_{2.5}$ at sensitive receptors is 0.125 mg/m^3, equivalent to 167% of standard and occurs in Beidong Village.

362. The main reason for exceedance of $PM_{2.5}$ and PM_{10} is that the environmental background data exceed relevant standards.

363. It should be noted that these worst case cumulative GLC exceedances are a result of high worst case ambient levels of $PM_{2.5}$ and PM_{10}, and not as a result of the emissions from the component; in fact, component emissions accounts for only a small percentage of ambient levels. Nonetheless, during the operation phase gas emissions will be sampled on a regular basis and also be monitored by CEMS system installed at the stack to confirm compliance with relevant PRC emission standards, and ambient monitoring will be undertaken through the Jinan EPB Continuous Ambient Air Quality Monitoring Stations and 3rd party environmental monitoring companies. Calibration of the CEMS system will be quarterly implemented by Jinan EPB.

Table V-15: Scenario 2 worst case GLCs. Unit: mg/m^3

Emission factor (Max. GLC)		Predicted GLCs		Background values	Predicted GLCs with background value				GB3095-2012 / WHO standard IT-1 and guidelines
		Concentration	Ratio to national standard (%)	Concentration	Concentration	Ratio to national standard (%)	Ratio to WHO standard IT-1 (%)	Ratio to WHO guideline (%)	
NH_3	1-hour	4.16E-03	0.208	0.160	0.164	82.1%	NA	NA	2.0/NA/NA
SO_2	1-hour	1.51E-02	3.02	0.108	0.123	24.6%	NA	NA	0.5/NA/NA
	24-hour	9.67E-04	0.645	0.072	0.072	48.0%	57.6%	360.0%	0.15/0.125/0.02
	Annual	1.71E-04	0.285	0.025	0.025	42.0%	NA	NA	0.06/NA/NA
NO_2	1-hour	1.09E-02	5.45	0.067	0.078	39.0%	NA	39.0%	0.2/NA/0.2
	24-hour	1.88E-03	2.35	0.051	0.053	66.1%	NA	NA	0.08/NA/NA
	Annual	3.32E-04	0.83	0.046	0.046	115.8%	NA	115.8%	0.04/NA/0.04
$PM_{2.5}$	1-hour	NA	NA	NA	NA	NA	NA	NA	NA/NA/NA
	24-hour	1.60E-04	0.213	0.125	0.125	166.9%	166.9%	500.6%	0.075/0.075/0.025
	Annual	2.82E-05	0.081	0.063	0.063	180.1%	180.1%	630.3%	0.035/0.035/0.01
PM_{10}	1-hour	NA	NA	NA	NA	NA	NA	NA	NA/NA/NA
	24-hour	3.20E-04	0.213	0.209	0.209	139.5%	139.5%	418.6%	0.15/0.15/0.05
	Annual	5.65E-05	0.081	0.130	0.130	185.8%	185.8%	650.3%	0.07/0.07/0.02

Table V-16: Worst case SO_2 cumulative (worst case predicted + worst case background) GLCs at monitoring sites. Unit: mg/m³

No.	Name	1-hour				24-hour			
		Background	Worst case GLC	Worst case Cumulative GLC	Ratio of GLC to national standard	Background	Worst case GLC	Worst case Cumulative GLC	Ratio of GLC to national standard/ WHO interim T-1/Guideline value
1	Gaowang Village	0.092	0.003725	0.095725	0.19/	0.058	0.000322	0.058322	0.39/0.47/2.9
2	Beiwangtang Village	0.105	0.004002	0.109002	0.22	0.065	0.000414	0.065414	0.44/0.52/3.3
3	Caomiaowang Village	0.056	0.003926	0.059926	0.12	0.056	0.000642	0.056642	0.38/0.45/2.8
4	Tianjia Village	0.063	0.003299	0.066299	0.13	0.063	0.000405	0.063405	0.42/0.51/3.2
5	Beidong Village	0.072	0.003364	0.075364	0.15	0.072	0.000534	0.072534	0.48/0.58/3.6
6	Huaizhuang Village	0.069	0.003741	0.072741	0.15	0.069	0.000352	0.069352	0.46/0.55/3.5

Table V-17: Worst case NO_2 cumulative (worst case predicted + worst case background) GLCs at monitoring sites. Unit: mg/m^3

No.	Name	1-hour				24-hour			
		Background	Worst case GLC	Worst case Cumulative GLC	Ratio of GLC to national standard/WHO Guideline	Background	Worst case GLC	Worst case Cumulative GLC	Ratio of GLC to standard/WHO Guideline
1	Gaowang Village	0.059	0.00726	0.06626	0.33/0.33	0.04	0.000628	0.040628	0.51/NA
2	Beiwangtang Village	0.065	0.007799	0.072799	0.36/0.36	0.047	0.000807	0.047807	0.60/NA
3	Caomiaowang Village	0.065	0.007651	0.072651	0.36/0.36	0.049	0.001252	0.050252	0.63/NA
4	Tianjia Village	0.062	0.00643	0.06843	0.34/0.34	0.045	0.00079	0.04579	0.57/NA
5	Beidong Village	0.059	0.006555	0.065555	0.33/0.33	0.051	0.001041	0.052041	0.65/NA
6	Huaizhuang Village	0.067	0.007292	0.074292	0.37/0.37	0.048	0.000685	0.048685	0.61/NA

Table V-18: Worst case PM_{10} cumulative (worst case predicted + worst case background) GLCs at monitoring sites. Unit: mg/m^3

No.	Name	24-hour			
		Background	Worst case GLC	Worst case Cumulative GLC	Ratio of GLC to national standard/WHO Interim T-1/WHO Guideline
1	Gaowang Village	0.201	0.000107	0.201107	1.34/1.68/4.0
2	Beiwangtang Village	0.199	0.000137	0.199137	1.33/1.33/4.0
3	Caomiaowang Village	0.186	0.000213	0.186213	1.24/1.24/3.7
4	Tianjia Village	0.175	0.000134	0.175134	1.17/1.17/3.5
5	Beidong Village	0.209	0.000177	0.209177	1.39/1.39/4.2
6	Huaizhuang Village	0.199	0.000116	0.199116	1.33/1.33/4.0

Table V-19: Worst case $PM_{2.5}$ cumulative (worst case predicted + worst case background) GLCs at monitoring sites. Unit: mg/m^3

No.	Name	24-hour			
		Background	Worst case GLC	Worst case Cumulative GLC	Ratio of GLC to national standard/WHO Interim T-1/WHO Guideline
1	Gaowang Village	0.000053	0.114053	0.114106	1.52/1.52/4.6
2	Beiwangtang Village	0.000068	0.118068	0.118136	1.57/1.57/4.7
3	Caomiaowang Village	0.000106	0.115106	0.115212	1.53/1.53/4.6
4	Tianjia Village	0.000067	0.097067	0.097134	1.29/1.29/3.9
5	Beidong Village	0.000088	0.125088	0.125176	1.67/1.67/5
6	Huaizhuang Village	0.000058	0.113058	0.113116	1.51/1.51/4.5

2. Stack height

364. Based on United States 40 CFR, part 51.100 (ii), Good International Industry Practice (GIIP) stack height should follow the formula $H_G = H + 1.5L$; where

H_G = Stack height measured from the ground level elevation at the base of the stack,

H = Height of nearby structure(s) above the base of the stack.

L = Lesser dimension, height (h) or width (w), of nearby structures.

“Nearby structures” = Structures within/touching a radius of 5L but less than 800 m.

365. Based on site visit, the nearby structures are the cooling tower and office buildings in JNMIP (**Figure V-16**). H is 45m (cooling tower) and L is 20m. Therefore, for this component, H_G = 45+1.5*20=75m. The designed stack height of this component is 100m, which means stack height meets GIIP.

Figure V-17: Nearby structures

366. To address air pollution issues, good practice air pollution management measures per the thermal power EHS Guidelines and the following measures will be implemented:

(i) Bag filters will be installed at the top of ash and slag warehouse for dust removal.

(ii) Low NOx burner, desulfurization system, denitration system and dust removal system will be installed to treat the exhaust gas before final emission.

(iii) CEMS system will be installed at the stack to monitor the exhaust gas.

(iv) Use of loading and unloading equipment that minimizes the height of biomass briquettes drop to the stockpile to reduce the generation of fugitive dust and installing cyclone dust collectors.

(v) Use full enclosure during transportation of biomass briquettes and covering stockpiles where necessary.

(vi) Offsets will be taken by replacing existing coal-fired boilers and household coal stoves. 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.

(vii) Geothermal-wells will be sealed if H_2S or Hg is identified to be over the level of 5 ppm during construction.

(viii) If the pollution control measures break down, the IA will take emergency response measures including temporary shutting down the operation.

3. Water supply and wastewater pollution

367. The component will have 80 staff and daily domestic water consumption is 8 tons and annual is 2400 tons (300 working days). There is one water supply plant in JNMIP with a capacity of 110,000 tons per day. The total municipal water consumption is very limited compared to JNMIP's water supply capacity. This is not expected to result in any significant negative impact on JNMIP's water supply. Water supply agreement will be signed before the operation of the component.

368. The component will utilize reclaimed water from WWTP of JNMIP for production water. WWTP of JNMIP started operation from 2015. The wastewater treatment capacity is 30,000 tons per day, which will be discharge into Tuhai River. The designed maximum reclaimed water consumption of the component is around 740 m^3/d, which accounts for 2.5% of the wastewater treated. This will have no impact on the environmental flow of the receiving water body – Tuhai River with annual average water flow of 268.73 m^3.

369. The component will use municipal water as domestic water and reclaimed water as production water. Domestic wastewater will be produced from canteens and toilet facilities. Production wastewater will include wastewater from boiler system, chemical water treatment workshop and circulation system.

370. Based on **Table III-18**, once operational, annual wastewater discharged by the component will be 150,552m^3 and pollutants concentration in the wastewater is presented in **Table V-20** 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 WWTP of JNMIP and discharged to Tuhai River by pipeline. Estimated COD and ammonia nitrogen discharged by the component are 7.53 and 0.75 tons respectively.

Table V-20: Wastewater quantity and quality

Item	Annual flow (m^3)	Unit	COD	Ammonia nitrogen
Wastewater generated by the component	150,552	mg/L	146	15.5
		tons	21.98	2.33
Pollutants concentration in treated water from the WWTP	150,552	mg/L	50	5
		tons	7.53	0.75

371. 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 pre-treatment process and concentrated water from chemical water treatment workshop and boiler blow down will be discharged to the municipal sewerage system.

(ii) Because drainage from circulation system is clean, part of the drainage will be recycled for dust control in workshops and the rest will be discharged to the municipal sewerage system.

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

(iv) 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.

(v) Wastewater from desulfurization system will be pre-treated by aerated oxidation, and then alkali will be used to adjust pH of wastewater to make the metal precipitate. After the pH adjustment, organic sulfur and flocculant agent will be added to make magnesium sulfite precipitate. Treated wastewater will be discharged to the municipal sewerage system.

(vi) Because of the high operation temperature of denitration system, no wastewater but steam will be discharged by denitration system.

(vii) 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.

(viii) For deep geothermal wells, extracted water and recharged water are in a closed system which mean no wastewater water will be generated during operation. Because there is a filter process installed in the closed system for groundwater filter, wastewater generated during operation will be from filter back wash and will be discharged to the municipal sewerage system.

(ix) Well casing and pipes will be designed to avoid corrosion. An emergency water tank will be prepared for temporary storage of geothermal groundwater in case the injection well is blocked or leak happens due to flocculation or corrosion.

4. Solid Waste

372. The component will generate a domestic waste and production waste. Production waste will be generated from boilers, desulfurization system, loading and unloading sites. reclaimed water pre-treatment process and chemical water treatment process. Production waste will include ash, slag, byproduct from desulfurization system, sludge from reclaimed water pre-treatment workshop and oily waste from equipment maintenance. Detailed information is presented in **Table III-19**. 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 Geothermal Power Generation, and EHS Guidelines for Thermal Power Plants 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) Ash and slag will be sold to be reused as fertilizer.

(v) Ash and slag will be transferred in closed tank truck.

(vi) Water will be sprayed at ash and slag loading and unloading site.

(vii) Byproduct from desulfurization and sludge from reclaimed water pretreatment will be treated by filter press, and then sold to be recycled as construction materials.

(viii) Transfer of byproduct from desulfurization and sludge will be implemented by 3rd party certified company.

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

5. Chemicals and Hazardous Materials

373. Toxic, hazardous, and harmful materials present in the operation of the component include petroleum products, solvents, scale and corrosion inhibitors and chemicals used for water analysis and purification (which are which are Ethylene Diamine Tetraacetic Acid, Silver nitrate standard solution, Dilute sulphuric acid standard solution, Potassium chromate indicator, Eriochrome 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 waste urea, oily waste, waste chemicals and waste ion exchange resin stored in temporary closed containers with warning signs and collected and disposed by licensed contractors on an as needed basis. Urea will be stored in a 30 m^3 warehouse with leak detector and warning signs.

(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.

6. Noise

374. Noise sources during operation will mainly be from noise from pumps, boiler, power generator, transformer etc. 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.

375. Based on operation data of similar CHP plant with low-noise equipment, noise reduction measures such as noise elimination, shock absorption, insulated enclosures and sound dampening materials on exterior walls, noise emission by the component is presented in **Table V-21**.

Table V-21: Main noise sources and mitigation measures

Noise Source	Estimated Noise Emission dB(A)	Mitigation Measures	Estimated Noise Emission after mitigation dB(A)
Turbine	85-90	Sound absorber, vibration attenuation, acoustic shield, exhaust-gas muffler	70-75
Boilers	80-85	Sound absorber, vibration attenuation, acoustic shield, exhaust-gas muffler	65-70
Generator	80-85	Sound absorber, vibration attenuation, acoustic shield, exhaust-gas muffler	65-70
Circulating water pump	70-75	Vibration attenuation, sound insulation	60-65

Heat pump	70-75	Vibration attenuation, sound insulation	55-60
Make-up pump	65-70	Vibration attenuation, sound insulation	55-60
Air compressor	80-85	Vibration attenuation, sound insulation	70-75
Transformer	70-75	Vibration attenuation, sound insulation and reasonable layout	60-65
Cooling tower	70-75	Vibration attenuation, exhaust air muffler	60-65

Source: Domestic EIA, 2018.

376. Noise modeling is implemented in domestic EIA based on Technical Guidelines for EIA – Acoustic Environment (HJ 2.4-2009) There are three prediction modes in this guideline for predicting point noise sources at outdoor, for indoor noise sources and cumulative results for different noise sources. The estimated noise levels at the biomass CHP site boundaries are presented in **Table V-22** and noise level at the nearby sensitive receptors are presented in **Table V-23**. Noise contour map of the plant during operation is presented in **Figure V-17**.

377. **Figure V-17**, **Table V-22** and **Table V-23** indicates that noise levels during operation can comply with relevant standards.

Table V-22: Estimated noise level at the site boundaries during operation

Location	Daytime (dB(A))		Compliance status	Nighttime (dB(A))		Compliance status
	Estimated noise level	Limit		Estimated noise level	Limit	
West boundary	42.3	65	Yes	42.3	65	Yes
South boundary	38.8	65	Yes	38.8	65	Yes
East boundary	42.6	65	Yes	42.6	65	Yes
North boundary	36.6	65	Yes	36.6	65	Yes

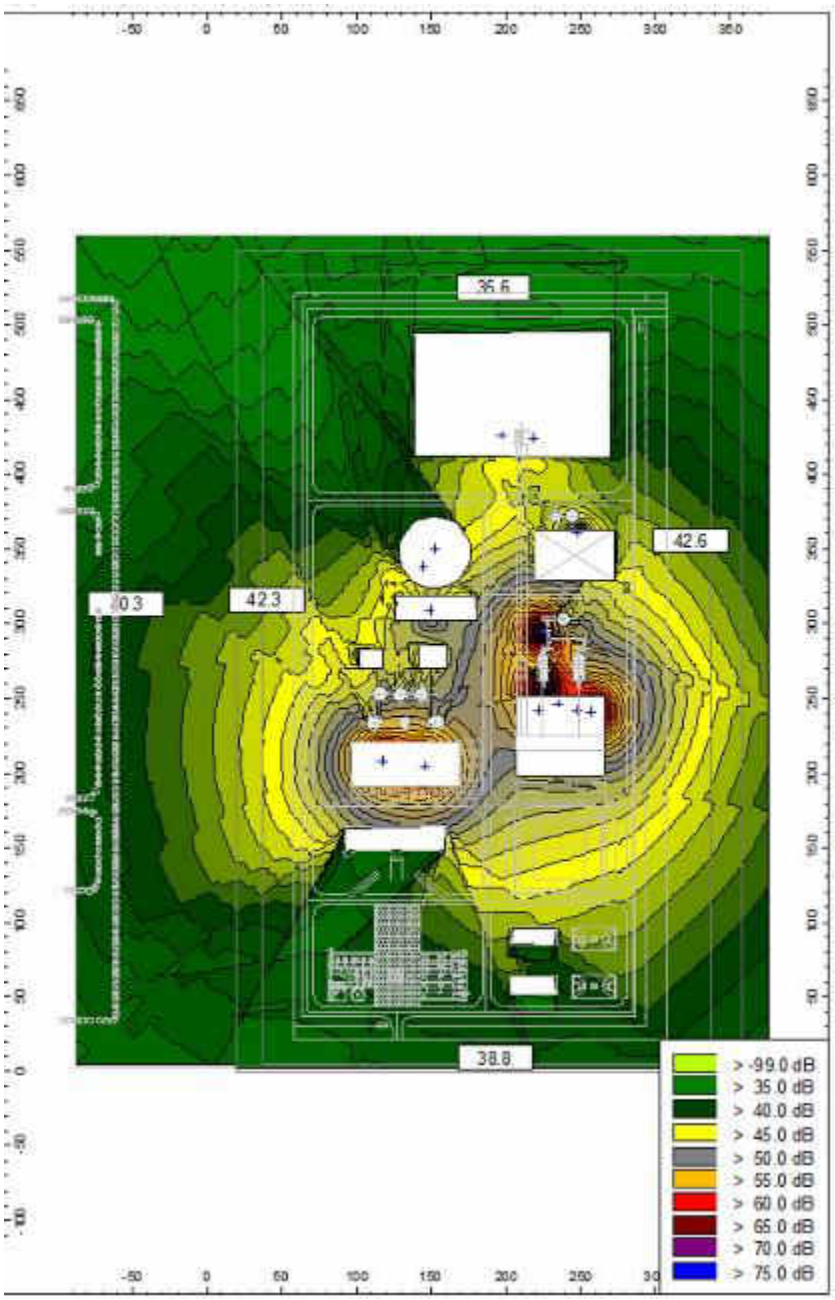
Source: Domestic EIA, 2018.

Table V-23: Estimated noise level at the sensitive receptor during operation. Unit: dB(A)

Location	Daytime background noise	Noise from the plant	Cumulative noise	Limit	Daytime background noise	Noise from the plant	Cumulative noise	Limit
Zhouyan Village	49.0	40.3	49.5	55	36.0	40.3	41.7	45

Source: Domestic EIA, 2018.

Figure V-18: Noise contour map during operation



Source: Domestic EIA, 2018.

7. Community and Occupational Health and Safety

378. Plant operation poses potential risks to workers and community, including well blowout, H_2S exposure, seismic risk and fire, explosion of biomass CHP, and potential generation of ammonia from urea.

379. To mitigate potential health and safety risks to workers, the following measures and good practice measures per the EHS Guidelines on occupational H&S, EHS Guidelines for Thermal

Power Plants and EHS Guidelines for Geothermal Power Generation 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) The nearby communities will be informed of the potential risks of well blowout, H_2S exposure, seismic risk, fire and explosion of biomass CHP and potential generation of ammonia from urea and the emergency response plan.

(iii) PPE including goggles, gloves, safety shoes will be provided to workers. Correct standard dust masks will be provided to workers working with biomass. Noise protection equipment will be provided to workers in high-noise area. Noise areas with more than 85 dBA shall be marked and hearing protections shall be provided to workers. Appropriate masks will be provided to workers in urea area following the PRC standards.

(iv) Storage of urea will follow the PRC General storage guideline for common chemicals (GB 15603-1995).

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

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

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

(viii) Daily average numbers for vehicles transporting biomass fuels are 23.5 times (load of one vehicle is 20 tons and working days are 300 days), which has a limited impacts to traffic flow. Transportation route of the vehicles will use the existing expressway and urban roads except exit and entrance. Vehicles transporting materials or wastes will slow down to 30 km/h and not use their horn when passing through or nearby sensitive locations, such as residential communities, schools and hospitals.

(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) Component site will be fence with restricted public access.

(xi) Potential occupational electric and magnetic fields (EMF) exposure should be prevented/minimized through identifying potential exposure levels in the workplace, training of workers in the dentification of occupational EMF levels and hazards, implementing action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations. Personal exposure monitoring equipment should be set to warn of exposure levels that are below occupational exposure reference levels (e.g., 50 percent).

(xii) 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.

(xiii) For fire and explosion hazard: use of automated combustion and safety controls; proper maintenance of boiler safety controls; use of automated systems such as

temperature gauges or carbon monoxide sensors to survey biomass storage areas to detect fires caused by self-ignition and to identify risk points; storing flammables away from ignition sources and oxidizing materials; defining and labeling fire hazard areas.

(xiv) Managing closure of well heads including sealing well with cement, removing the well head, and backfilling depression around the well head, as necessary.

8. Emergency Response Plan

380. 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 of well blowout, H_2S exposure, seismic risk and fire, explosion of biomass CHP, and potential generation of ammonia from urea. The nearby communities will be informed of the potential risks of well blowout, H_2S exposure, seismic risk, fire and explosion of biomass CHP and potential generation of ammonia from urea and the emergency response plan. Major elements of the emergency response plan are presented in **Table 2** of Appendix I.

D. Anticipated Positive Operation Phase Impacts

381. The component will deliver significant positive social impacts to beneficiaries through the delivery of 510,624 GJ of heating and 13.30253 million kWh of electricity. The component.

382. Instead of coal the component will use a mix of cleaner and renewable heat sources such as biomass and geothermal energy. When compared to the equivalent production of heat and power through traditional coal-fired sources, once operational the component will: (i) result in annual energy savings equivalent to 63,374.4 tce, thereby providing a global public good by avoiding the annual emission of 168,524.25 tons of CO_2; (ii) improve local air quality through the estimated annual reduction of emissions of SO_2 by 87.86 tons, NOx by 39.85 tons, and PM by 7.02 tons; and (iii) eliminate the negative impacts of coal transportation through urban areas by truck or train.

Table V-24: Coal and emission reduction calculations

Item	Technology adopted	Heating area (m^2)	Energy consumption	Energy consumption TCE (tons)	Pollutants emission (tons)			
					CO_2	SO_2	NOx	PM
Component	Biomass CHP	1,536,000	Biomass 155,500 tons	0[1]	NA[2]	35.7	83.7	11.5
	Geothermal energy (1.2 MW)	24,571.7	Electricity 339,089.5 kWh[3]	41.7[4]	245.94	0.12[5]	0.13[5]	0.03[5]
Baseline	Coal based CHP	1,560,572	Coal 21,848.0 tce	64,416.1[6]	168,770.19[7]	123.68[8]	123.68[8]	18.55[8]

			Electricity 6,741,671.0 kWh					
Savings	NA	NA	NA	64,374.4	168,524.25	87.86	39.85	7.02

Note:

1. Because the component will utilize part of the power generated by the component for operation, energy consumption is 0.
2. Only CO_2 savings is calculated in terms of using coal to generate the same amount of electricity.
3. Based on operating experience of JTPC, electricity consumption intensity of deep geothermal heating is 13.8kWh/m^2/a;
4. 1 kWh is equality to 0.1229 kg standard coal;
5. 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.
6. Based on operating data of JTPC, in 2017-2018 heating season, coal consumption intensity for heat supply was 0.014tce/m^2/a and coal consumption intensity for power generation was 320g tce/kWh. The component will provide heat 510,624 GJ to an area of 1.536 million m^2 annually and produce 13.30253 million kWh power to the electric power grid annually.
7. Based on data from NDRC, burning 1t standard coal produces 2.62t CO_2.
8. According to Air Pollutants Emission Standards for Boilers (GB13271-2014), the PM, SO_2, and NOx emission standard is 30mg/m^3, 200 mg/m^3, and 200 mg/m^3respectively. Burning 1kg standard coal produces 9.6Nm^3 waste gas, and produces 1.92 g SO2, 1.92 g NOx and 0.288 g PM.

VI. ANALYSIS OF ALTERNATIVES

383. 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

384. 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.

385. 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.

386. 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.

387. The component's implementation will: (i) fulfil rapidly increasing heat demand; (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 biomass and geothermal 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

388. 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.

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

390. Based on No Project Alternative analysis, coal based CHPs and HSPs are not acceptable. China is not in rich in natural gas. In 2017, China purchased 92.0 billion m^3 natural gas from foreigner countries and the total natural gas consumption in China in 2017 was 237.3 billion m^3. Considering the natural gas shortage of northern China occurred in 2017 heating season led by coal-to-gas switch in northern China and Jinan is not rich in natural gas, natural gas in Jinan is not a good choice in recent years.

391. 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.

392. 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.

393. Because JNMIP is still under development, existing heat load of JNMIP is limited. Therefore, HSP plant is not a good choice.

394. Based on chapter III of this report, there are plenty of biomass resources especially straw near the component site. A common straw treatment in Shandong Province is open burning which results in air pollution.

395. This component will use 155,500 tons of biomass which will drastically help improve the open burning issue in Jinan, therefore contribute to the air quality improvement in the greater BTH.

396. The component uses highly efficient pumps and blowers with variable frequency drive, the energy efficiency will be improved. The component will use cyclone dust removal and bag filter as dedust system (efficiency of 99.9%). The component uses mixed biomass and wood chips as fuel with the low sulfur content of 0.15%. In addition, the circulated fluidized boiler technology is good for removing sulfur from the chamber and is also a good option. This circulated fluidized boiler equipped with low-NOx burners, the NO_x production will be reduced. Selective non-catalytic reduction for de-NO_x will be utilized as an add-on control of NOx from flue gas. The component can meet all applicable emission requirements.

397. Compared to coal, the biomass produces low net NOx, SO_2 and PM. The biomass also produces low net total greenhouse gas emissions because the materials used are already a part of the carbon cycle.

398. Overall, the component has selected the most appropriate fuel type.

C. Deep geothermal energy

399. Geothermal energy is a clean and renewable energy source deriving from the exploitation of the heat flux reaching the surface from the deeper part of the Earth's crust. The heat can be utilized in district heating. There are two technical options for geothermal heating. One is shallow geothermal utilization and the other is deep-well geothermal utilization.

400. Shallow-ground source heating involves extracting geothermal energy from ground water at around 16°C, via heat exchange tubes buried at a depth of 80 – 120 meters, then using a heat pump to increase the temperature to around 50°C. The advantages of this technology are: (i) deep drilling technology is not necessary, and there is minimal impact on groundwater resources; (ii) the COP of Shallow-ground source heat pump is above 4, which is higher than those of air source heat pump or electric boiler, etc. (iii) detailed geothermal resource survey data is not necessary. However, this technology also has disadvantages, mainly is that multiple shallow wells may be needed to draw enough heat energy. Generally, the proportion of areas for buried tube against heating area is 1:3. Hence, it could not be used for large areas. Secondly, a large amount of electricity will still be consumed by the heat pump during the heating period. The power consumption is 39 kWh for heating per square meter per heating period (assuming 15 hours per day and 120 days per year). Thirdly, heating and cooling imbalance will lead to the decay of geothermal energy after long time of operation.

401. The other option, deep-well geothermal energy involves extracting ground water around 50 – 60°C at the depth of 1,000-2,000 meters, and heat exchanging via indirect counter current heat exchangers for heat supply. The water extracted from ground will then be filtered and recharged back underground. The whole system consists of geothermal well, pump room and pipe networks, among those the water pump is the only energy-consuming equipment. Compared to Shallow-ground source heat pump, deep-well geothermal energy has the tri-fold advantages of less land acquisition, stable heating and low maintenance cost. To make full use of the heat from ground water, heat pumps can be used to make the water to a higher temperature. However, the environmental risk of deep-well geothermal energy is the potential impact to underground water quantity and quality, so it is important to make sure that the extracted water is filtered and 100% recharged back. The component will ensure 100% recharge of the groundwater. The ground water will be extracted and recharged in a closed system and no wastewater will be generated. Therefore, the component will not have impact to groundwater quantity and quality.

402. Weighing between the two technologies explained above, the deep well geothermal energy can be used for direct district heating which is more cost benefit compared to Shallow-ground geothermal energy, thus the component is to adopt deep well geothermal energy technology for district heating.

403. Based on domestic FSR, there are already four existing deep geothermal wells near the component site. Based on information from these wells, the depths of the wells are 1,810-1,875 m, temperatures of groundwater are 61-63°C, the flows are 1,300-1,746.08 m3/d, hydrochemical types are Cl-Na type of Cl.SO4- Na type and salinity is 0.641-0.809 g/L. From the information, it can be concluded that deep geothermal energy near the component site can provide enough heat for the component.

404. Geothermal energy is a renewable and clean energy. To facility deep geothermal energy utilization near the component site, it is necessary to install two demonstration deep geothermal wells in the component.

D. Pipeline Network

405. The component will utilize direct-buried pre-insulated bonded pipeline, which is by far the most commonly used technology for both new district heating and cooling 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.

406. 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

407. Based on the analysis of alternatives, the component has selected the most appropriate

and sustainable heat source, pipeline type and geothermal utilization method.

VII. INFORMATION DISCLOSURE AND PUBLIC CONSULTATION

A. PRC and ADB Requirements for Disclosure and Public Consultation

1. PRC Requirements

408. 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.

409. 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.[21]

410. 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.

411. 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

412. 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.

413. 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:

[21] 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.

414. 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

415. EIA Institute has undertaken public consultation and information disclosure in accordance with the Interim Guidelines on Public Consultation for EIA (2006) during EIA process. Two rounds of public consultation are implemented.

1. Phase 1: Public Consultation and Information Disclosure by EIA Institute

416. IA disclosed the information of the component in two steps :

(i) The first public information notice was posted on the Jinan Tianqiao Government's website in February 2015, early in the EIA preparation process. The information in the first public notification (The link is http://www.tianqiao.gov.cn/art/2015/2/3/art_112_126626.html) is listed below:

(a) Name and summary of the component.

(b) Name and contact information of the construction company.

(c) Name and contact information of the institute responsible for preparing the EIA of the component.

(d) EIA procedures and content.

(e) Type of EIA notification notice.

(f) Request for questions, suggestions and feedback from the public.

(ii) A second public information notice was also posted on the Jinan Tianqiao Government's website from March 2015 to April 2015, prior to the submission of the draft EIA report to the Jinan EPB. The link is http://www.tianqiao.gov.cn/art/2015/3/11/art_112_128492.html. The notice included Project name and information below:

(a) Name and summary of the component.

(b) Name and contact information of the institute responsible for preparing the EIA report.

(c) Name and contact information of the institute responsible for approval of

the EIA report.

(d) Name and contact information of the construction company.

(e) Potential project environmental impacts and mitigation measures during construction phase and operation phase.

(f) Key conclusions of the EIA report.

(g) Contact information to get abridged versions of the EIA report.

417. No public feedback was received during two rounds of public information disclosure.

Figure VII-1: Information disclosure on Jinan Tianqiao Government's website

(i) First information disclosure

(ii) Second information disclosure

418. During the second information disclosure, the EIA Institute conducted surveys in the nearby villages. The questionnaires targeted beneficiaries and potentially affected persons by the component. The survey information is presented in **Table VII-1**.

Table VII-1: Survey information

No.	Name	Direction	Distance (m)	Population	Participants
1	Beiwangtang Village	NNW	1000	252	30
2	Caomiaowang Village	WSW	725	550	59
3	Beidong Village	S	740	556	60
4	Dazheng Village	NNW	840	187	21
5	Xiaozheng Village	N	750	145	15
6	Zhouyan Village	W	91.72	928	94
Total				2618	279

419. A total of 279 questionnaires were distributed and 279 were retrieved, a recovery rate of

100%. A sample questionnaire is presented in **Table VII-2**.

420. Information of participants is presented in **Table VII-3**. The survey covered a wide age range. 60.6% of respondents were male and the remainder female. 100% were Han. 7.5% of respondents had an education level of primary school, 56.6% had an education level of middle school and 35.8% had an education level of high school or above. 39.4% were female participants. The occupations of the respondents were quite diverse, representing the opinions of a wide range of Project stakeholders.

421. **Table VII-4** presents a summary of the questionnaire results.

422. Overall support for the project is very strong; 87.8% of the respondents indicated that the project will improve local economic development, 100% indicated that the project's environment protection measures are reliable and efficiency, and 100% of respondents indicated that they support the proposed project.

Table VII-2: Project public consultation questionnaire (2015)

Name		**Sex**		**Age**	
Nationality		**Education level**		**Occupation**	
Company		**Title**		**Contact number**	
1. What is your opinion to the environment near the project site? A. Good B. Fair C. Slightly polluted D. Heavily polluted					
2. With good implementation of exhaust gas treatment measures, what is the impact to ambient air by the project? A. No impact B. limited impact C. Big impact D. Significant impact					
3 With good implementation of wastewater treatment measures, what is the impact to water environment by the project? A. No impact B. limited impact C. Big impact D. Significant impact					
4. With good implementation of noise control measures, what is the impact to acoustic environment by the project? A. No impact B. limited impact C. Big impact D. Significant impact					
5. With good implementation of waste management measures, what is the impact to environment by the project? A. No impact B. limited impact C. Big impact D. Significant impact					
6. With good implementation of environment protection measures, what is the impact to ecology by the project? A. No impact B. limited impact C. Big impact D. Significant impact					
7. With good implementation of risk control measures, do you think the company can prevent accident? A. Yes B. No C. Not clear					
8. What is the impact of the project during construction period? A. No impact B. limited impact C. Big impact D. Significant impact					
9. Do you the construction of this project is necessary? A. Yes B. No C. Not clear					
10 What are environmental issues of highest concern during operation period? A. Water pollution B. Ambient air pollution C. Noise D. Others					
11 Do you think the environment protection measures are reliable and efficiency? A. Yes B. No C. Not clear					
12. Do you think construction of this project can improve local economic development or not? A. Yes B. No C. Not clear					
13. After comprehensive analysis of project advantages and disadvantages, do you agree with the construction of this project? A. Yes B. No C. Not clear					
Suggestions or requirements of the project:					
Suggestions or requirements for environment protection of the project:					
Project information *(a project summary was provided here), anticipated pollution control measures and environment benefits.*					

Table VII-3: Questionnaire respondent information

Parameter		No	%
Age	Below 20	1	0.4%
	21-30	41	14.7%
	31-40	104	37.3%
	41-50	108	38.7%
	51-60	20	7.2%
	Above	5	1.8%
Education level	Primary school	21	7.5%
	Middle school	158	56.6%
	High school or above	100	35.8%
Sex	Male	169	60.6%
	Female	110	39.4%
Nationality	Han	279	100%
	Other	0	0
Occupation	Farmer	12	75.3%
	Worker	10	9.0%
	Self-employed entrepreneurs	12	4.3%
	Civil servant	7	3.2%
	Other	13	8.2%

Table VII-4: Public consultation questionnaire results

Question	Answer	No.	%
1. What is your opinion to the environment near the project site?	A. Good	2	0.7%
	B. Fair	250	89.6%
	C. Slightly polluted	27	9.7%
	D. Heavily polluted	0	0.0%
	A. No impact	100	35.8%

2. With good implementation of exhaust gas treatment measures, what is the impact to ambient air by the project?	B. limited impact	175	62.7%
	C. Big impact	4	1.4%
	D. Significant impact	0	0.0%
3. With good implementation of wastewater treatment measures, what is the impact to water environment by the project?	A. No impact	92	33.0%
	B. limited impact	187	67.0%
	C. Big impact	0	0.0%
	D. Significant impact	0	0.0%
4. With good implementation of noise control measures, what is the impact to acoustic environment by the project?	A. No impact	167	59.9%
	B. limited impact	112	40.1%
	C. Big impact	0	0.0%
	D. Significant impact	0	0.0%
5. With good implementation of waste management measures, what is the impact to environment by the project?	A. No impact	114	40.9%
	B. limited impact	135	48.4%
	C. Big impact	30	10.8%
	D. Significant impact	0	0.0%
6. With good implementation of environment protection measures, what is the impact to ecology by the project?	A. No impact	193	69.2%
	B. limited impact	57	20.4%
	C. Big impact	29	10.4%
	D. Significant impact	0	0.0%
7. With good implementation of risk control measures, do you think the company can prevent accident?	A. Yes	267	95.7%
	B. No	0	0.0%
	C. Not clear	12	4.3%
8. What is the impact of the project during construction period?	A. No impact	73	26.2%
	B. limited impact	202	72.4%
	C. Big impact	4	1.4%
	D. Significant impact	0	0.0%
	A. Yes	279	100%

9. Do you the construction of this project is necessary?	B. No	0	0.0%
	C. Not clear	0	0.0%
10. What are environmental issues of highest concern during operation period?	A. Water pollution	117	41.9%
	B. Air pollution	127	45.5%
	C. Noise	35	12.5%
	D. Other	0	0.0%
11. Do you think the environment protection measures are reliable and efficiency?	A. Yes	279	100.0%
	B. No	0	0.0%
Question	Answer	No.	%
	C. Not clear	0	0.0%
12. Do you think construction of this project can improve local economic development or not?	A. Yes	245	87.8%
	B. No	4	1.4%
	C. Not clear	30	10.8%
13 After comprehensive analysis of project advantages and disadvantages, do you agree with the construction of this project?	A. Yes	279	100.0%
	B. No	0	0.0%
	C. Not clear	0	0.0%

Source: Domestic EIA (2018).

2. Phase 2: Public Consultation and Information Disclosure by IA

(a) Beneficiary Social Analysis Surveys

423. 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.

424. 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.

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

(b) Information and EIA Disclosure

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

Figure VII-2: Information disclosure pictures

First information disclosure at Beiwangtang Village

First information disclosure at Xiaozheng Village

First information disclosure at Dazheng Village

First information disclosure at Caomiaowang Village

First information disclosure at Zhouyan Village

First information disclosure at Beidong Village

Second information disclosure at Beiwangtang Village

Second information disclosure at Xiaozheng Village

Second information disclosure at Dazheng Village

Second information disclosure at Caomiaowang Village

Second information disclosure at Zhouyan Village

Second information disclosure at Beidong Village

(c) Project Information Disclosure and Public Consultation Meeting

427. According to ADB SPS's requirements, the JTPC held a public consultation meeting on 10 January 2017 before the preparation of the EIA. A public project information notice was posted in the nearby villages for two weeks prior to the meeting. The meeting was held in the office of Zhouyan village committee and 22 nearby villagers were invited to the meeting. During the meeting information on the component construction content and status was presented by the 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 meeting ,most of believed that the component can provide a clean district heating service and provide more job opportunities to the nearby villages and 100% of participants supported the construction of component.

428. During the EIA preparation process, after a draft EIA was prepared by JTPC, JTPC conducted survey in nearby villages in April 2018. A total of 240 questionnaires (**Table VII-5**) were distributed and 240 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**.

429. **Table VII-6** presents summary data on the questionnaire respondents, while **Table VII-7** presents a summary of the questionnaire results.

430. Most of the respondents work and live within a 3 km radius of the project; 85.7% of respondents knew about project either from other person, newspapers or information signs, and 91.4% of respondents indicated that they were already familiar with the project benefits after the introduction of the project. 43.3% of the respondents were female. The top three environment issues respondents identified in their neighborhoods are air quality (37.1%), surface water (17.1%) and noise (14.3%). 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.

431. Overall support for the project is very strong; 94.3% of the respondents indicated that the project will improve local economic development; 90.0% indicated that the project will improve quality of life; and 91.7% of respondents indicated that they support the proposed project.

Table VII-5: 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 adverse impacts of the project during operation?	Clearly understand		
	Somewhat understand		
	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.			

Figure VII-3: Public consultation activities

(i) Presentation on project information by IA.

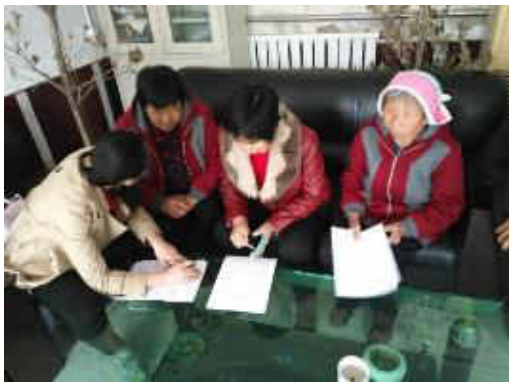
(ii) Discussion

(iii) Discussion between IA and consultants

(iv) Survey in Dazheng Village

(v) Survey in Caowangmiao Village

(vi) Survey in Xiaozheng Village



(vii) Survey in Zhouyan Village

(viii) Survey in Dadong Village

Table VII-6: Summary data on questionnaire respondents

Parameter	Indicator	No.	%
Sex	Male	136	56.6%
	Female	104	43.3%
Age	Below 30	16	6.7%
	31-40	16	6.7%
	41-50	80	33.3%
	Above 50	128	53.3%
Nationality	Han people	240	100.0%
	Other	0	0
Education Level	Primary School or Below	80	33.3%
	Junior school	128	53.3%
	High school, including technical secondary school	16	6.7%
	Bachelor degree or above, including junior college	16	6.7%
Occupation	Farmer	208	86.7%
	Employee	32	13.3%
	Civil servant	0	0
	Other	0	0

Table VII-7: 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	89	37.1%
	Noise	34	14.3%
	Surface water	41	17.1%
	Ground water	14	5.7%
	Soil	34	14.3%
	Solid waste	21	8.6%

	Odor	0	0
	Risks associated with chemicals and hazardous chemicals	0	0
	Other concern		
2. Distance between your working place and project site	<1 km	41	17.1%
	1-3 km	75	31.4%
	3-5 km	123	51.4%
	> 5km	0	0
3. Distance between your house and project site	<1 km	62	25.7%
	1-3 km	103	42.9%
	3-5 km	75	31.4%
	> 5km	0	0
4. Do you know this project before this public consultation?	Yes	206	85.7%
	No	34	14.3%
5. Do you understand environment impacts of this project before this public consultation?	Yes	151	62.9%
	No	48	20
	Not clear	41	17.1%
6. After this public consultation, are all the potential positive and adverse impacts of the proposed project components clear to you?	Clearly understand	219	91.4%
	Somewhat understand	14	5.7%
	Barely understand	7	2.9%
	Do not understand	0	0
7. In your opinion, what should be the most critical area that the project should focus on?	Exhaust air efficiency treatment	96	40
	Controlling fugitive emissions	14	5.7%
	Wastewater treatment	41	17.1%
	Groundwater protection	14	5.7%
	Soil protection	7	2.9%
	Chemicals handling	7	2.9%
	Odor control	0	0

	Make use of recyclable resources to reduce solid waste	0	0
	Noise disturbing to residents	34	14.3%
8.	Protection for community health and safety	14	5.7%
	Protection to workers health and safety	14	5.7%
	Others	0	0
9. Do you understand the potential adverse impacts during the construction of the proposed project?	Clearly understand	199	82.9%
	Somewhat understand	41	17.1%
	Barely understand	0	0
	Do not understand	0	0
10. What do you think about the project construction? Do you think it is necessary?	Necessary	178	74.3%
	Barely necessary	27	11.4%
	Not necessary	0	0
	It does not matter	14	5.7%
11. What would be the major impacts during project construction?	Noise	89	37.1%
	Dust	55	22.9%
	Solid waste	21	8.6%
	Traffic congestion	34	14.3%
	Others	0	0
	No major impacts	41	17.1%
12. Without mitigation measures, do you accept anticipated construction phase impacts?	Accept	192	80
	Barely accept	34	14.3%
	Do not accept	0	0
	Have no idea	14	5.7%
13. After learning about mitigation measures during the construction, do you accept anticipated construction phase impacts?	Accept	189	78.8%
	Barely accept	23	9.6%
	Do not accept	11	4.6%
	Have no idea	17	7.1%

14. Do you agree with project construction after comprehensive consideration?	Yes	201	83.8%
	No	22	9.2%
	I do not know	17	7.1%
15. Do you understand all the anticipated environmental adverse impacts of the project during operation?	Clearly understand	192	80.0%
	Somewhat understand	34	14.3%
	Barely understand	14	5.7%
	Do not understand	0	0
16. Do you understand all the anticipated health and safety adverse impacts of the project during operation?	Clearly understand	178	74.3%
	Somewhat understand	21	8.6%
	Barely understand	21	8.6%
	Do not understand	0	0
17. Do you understand the proposed mitigation measures during the project operation?	Clearly understand	199	82.9%
	Somewhat understand	27	11.4%
	Barely understand	14	5.7%
	Do not understand	0	0
18. Do you accept the impacts to ambient air quality by this project?	Accept	206	85.7%
	Barely accept	27	11.4%
	Do not accept	0	0
	Have no idea	7	2.9%
19. Do you accept the impacts to surface water quality by this project?	Accept	206	85.7%
	Barely accept	34	14.3%
	Do not accept	0	0
	Have no idea	0	0
20. Do you accept the impacts to ground water quality by this project?	Accept	213	88.6%
	Barely accept	21	8.6%
	Do not accept	0	0
	Have no idea	7	2.9%

21. Do you accept the impacts to acoustic environment quality by this project?	Accept	213	88.6%
	Barely accept	27	11.4%
	Do not accept	0	0
	Have no idea	0	0
22. Do you accept the solid waste pollution by this project?	Accept	219	91.4%
	Barely accept	14	5.7%
	Do not accept	0	0
	Have no idea	7	2.9%
23. Do you accept the impacts to ecological environment by this project?	Accept	206	85.7%
	Barely accept	14	5.7%
	Do not accept	0	0
	Have no idea	21	8.6%
24. Do you accept environment, health, and safety risks caused by this project?	Accept	213	88.6%
	Barely accept	27	11.4%
	Do not accept	0	0
	Have no idea	0	0
25. What are the major concerns of this project	Ambient air	89	37.1%
	Noise	75	31.4%
	Surface water	27	11.4%
	Ground water	14	5.7%
	Soil	14	5.7%
	Solid waste	14	5.7%
	Odor	0	0
	Risks associated with chemicals and hazardous chemicals	7	2.9%
	Other concern	0	0
26. Which is your top concern of this project?	Ambient air	117	48.6%
	Noise	62	25.7%

	Surface water	14	5.7%
	Ground water	14	5.7%
	Soil	0	0
	Solid waste	14	5.7%
	Odor	0	0
	Risks associated with chemicals and hazardous chemicals	21	8.6%
27. Do you think construction of this project can improve local economic development or not?	Yes	226	94.3%
	No	0	0
	I do not know	14	5.7%
28. Do you think whether construction of this project can improve your living quality such as better hear supply service?	Yes	240	90.0%
	No	0	5.4%
	I do not know	0	4.6%
29. Do you support the project?	Yes	220	91.7%
	No	9	3.8%
	I do not know	11	4.6%

C. Future Consultation Activities

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

433. The IA will continue to conduct regular community liaison activities during the construction and operations phases if needed, 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

434. 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

435. 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

436. 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

437. 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.

438. 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.

439. 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.

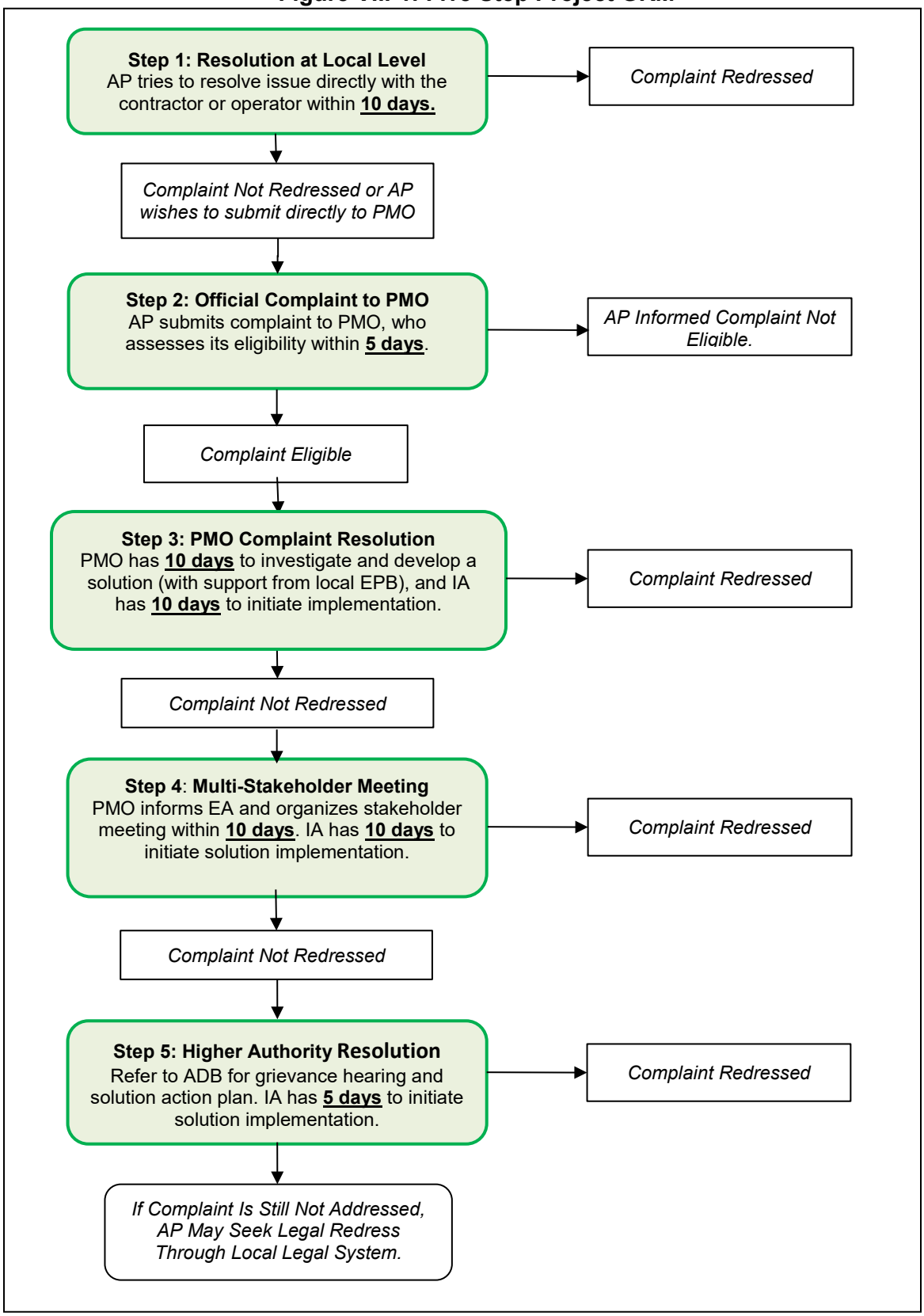
(ii) **Step 2:** The AP will submit the grievance to the PMO, who will record the grievance, assess its eligibility and report back to the AP within 5 working days. If the grievance is eligible, proceed to Step 3.

(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

440. This EIA report is for the proposed biomass Combined Heat and Power (CHP) component of the 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.

441. This component will provide district heating services to Jinan New Material Industrial Park (JNMIP) by multiple heating sources to ensure secure and efficient heat supply, including biomass CHP plant and geothermal energy.

442. The component scope includes: (i) 2×75 t/h high pressure and high temperature biomass CFB boilers with 2x15 MW extraction condensing turbines; (ii) 57.109 km of primary heating network; and (iii) two geothermal wells (one producing well and one disposal well). Once completed, the component will provide heat 510,624 GJ to an area of 1.536 million m^2 annually and produce 13.30253 million kWh power to the Grid annually.

443. 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 the equivalent production of heat and power through traditional coal-fired sources, once operational the project will: (i) result in annual energy savings equivalent to 63,374.4 tce, thereby providing a global public good by avoiding the annual emission of 168,524.25 CO_2; (ii) improve local air quality through the estimated annual reduction of emissions of SO_2 by 87.86 tons, NOx by 39.85 tons, and PM by 7.02 tons; and (iii) eliminate the negative impacts of coal transportation through urban areas by truck or train.

444. 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.

445. 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.

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Appendices

Appendix I: Environmental Management Plan

Appendix II: Existing Facility Due Diligence Environmental Review – Wastewater Treatment Plant of Jinan New Material Industrial Park

APPENDIX I: ENVIRONMENTAL MANAGEMENT PLAN

A. Objectives

1. This EMP is for biomass CHP 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 provide district heating services to Jinan New Material Industrial Park (JNMIP) by multiple heating sources to ensure secure and efficient heat supply, including biomass CHP plant and geothermal energy. The component will provide district heating to 1.536 million m^2 in which, 614,400 m^2 is for residential area and 921,600 m^2 is for industrial park and produce power which is sold to the Grid. Through energy saving and integration of clean and renewable energy sources, the component will reduce ambient air pollution in Jinan City.

3. The component will be implemented through four outputs:

(i) Output 1: One biomass CHP plant will be constructed with 2×75 t/h high pressure and high temperature biomass CFB boilers and 2x15 MW extraction condensing turbines;
(ii) Output 2: To demonstrate deep geothermal district heating system in Jinan, The proposed component will build two geothermal wells (one producing well and one disposal well) with a heat supply capacity of 1.2 MW to provide district heating to the biomass CHP plant (the heating area of the plant is 24,572 m2);
(iii) Output 3: District heating pipeline network will be constructed. Total length of the pipeline is 57.109 km; and
(iv) Output 4: Strengthened capacity to install and maintain clean heating technologies. The component activities will employ women and include awareness raising about the benefits of clean energy targeted toward women who are often responsible for domestic upkeep.

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 EIA. 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) coordinate 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 PMO 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).

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). An independent environmental expert will be engaged to verify the monitoring information and monitor the implementation of the EMP.

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 EIA and ensuring that if there are any changes in scope, the EIA/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 EIA/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 EIA 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.
Organization	- **Role and Responsibility**
	- 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 EIA and EMP and disclose on ADB website. - Approve updated EIA/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 EIA). 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.

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 EIA, the EMP and the domestic EIAs will be incorporated into the detailed design. Quantitative risk assessment by suitably qualified and experienced engineers will be conducted for well blowout, H_2S exposure, seismic risk and fire and explosion of biomass CHP plant under normal and emergency scenarios. A health and safety management plan will be developed to include appropriate measures to ensure risks to community is negligible and OHS risks can be managed to acceptable level. A dust management and monitoring plan will be developed in the detailed design. Recommendations in the detailed design will be implemented and included in the bidding documents.	PMO supported by LIEC	IA	Detailed Design Budget
	Include mitigation measures and monitoring program in bidding documents	Environmental mitigation measures identified in the EIA, 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	PMO supported by LIEC	IA	Detailed Design Budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		closely supervised against the PRC environmental laws, regulations and standards, ADB SPS, and the project EMP and approved domestic EIA.			
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: – Worker camp will be installed with sufficient portable toilets (based on the staff numbers, 4 toilets are sufficient) which will be provided for the workers and will be cleaned and discharged to the municipal sewerage system on a regular basis.	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 be directed to temporary detention and settling ponds, and then treated water will be partly recycled for use in dust control and the rest of treated water will be discharged to the local municipal sewer system and the waste residue in the tank is cleared and transported to designated certificated and engineered landfills by the local sanitation department personnel. If needed, polyacrylamide flocculent will be used to facilitate particle settling. All discharged construction wastewater will to be treated to meet the appropriate PRC standard GB/T 31962-2015 prior to discharge. Discharged water will then be treated in the WWTP of JNMIP. – Only water will used during drilling. No chemicals or bentonite mud will be used during drilling. – All necessary measures will be undertaken to prevent construction materials and waste from entering drains and water bodies. – Maintenance of construction equipment and vehicles will not be allowed on sites to reduce wastewater generation. – Oil traps are provided for service areas and parking areas, and oil-water separators are installed before the sedimentation tank for oil-containing wastewater; – 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			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		reduce wastewater generation; – Storage facilities for fuels, oil, and other hazardous materials are within secured areas on impermeable surfaces, and provided with bunds with 110% of the volume of materials stored 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); – Drilling equipment will be cleaned up before drilling to prevent ground water pollution. – Drilling water will be reused as much as possible during drilling. Waste water generated during drilling activities will be collected and toxicity assessment will be conducted. Cuttings will be reused if they are non-toxic (e.g. as construction fill) or disposed of in a landfill facility and wastewater will be discharged to municipal sewer system. If toxicity is found, cutting and wastewater will be transported for treatment by a certified company. Construction wastewater will be directed to temporary detention and settling ponds. Areas where construction equipment is being washed will be equipped with water collection basins and sediment traps. After settling, supernatant will be recycled and sediment will be periodically excavated, and either reused if possible as fill, disposed at official spoil disposal sites, or disposed at official or landfills.			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		– Maintenance of construction equipment and vehicles will not be allowed on site so as to reduce wastewater generation.			
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: – 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 transportation. – During earthworks the area of soil exposed to potential erosion at any one time will be minimized through good project and construction management. – 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 or other project sites to the maximum extent feasible as fill. Excess spoil that cannot be used on-site will be transported to an approved spoil disposal site.	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	
		– 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. – 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 (see greening plan). – Based on site visit, the spoil disposal site is closed to the component site at the north direction. Conduct project completion audit to confirm that spoil disposal site rehabilitation meets required standard, hold contractor liable in case of noncompliance – Storage tank for slurry will be lined to prevent the ingress of any contaminated slurry water into the soil.			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
Air Pollution	Dust, vehicle emissions, H_2S	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 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 dusty activities.	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 spoil, aggregate 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. Powdered materials such as cement and lime will be stored in sealed bags or containers. – Muddy or dusty materials on public roads outside the exits of works areas will be cleaned immediately. – Disturbed site will be revegetated as soon as possible after the completion of works. – On-site asphalting and concrete batching is prohibited. – Drilling sites will be fenced during drilling. Fence will be installed at site boundaries and dust monitoring will be implemented at Zhouyan Village to ensure compliance. – Dust monitoring at Zhouyan Village during construction. – Monitor H_2S during drilling. If the concentration is too high, the well will be shut down.			
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	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	
		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, 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). – Transportation routes and delivery schedules will be planned during detailed design to avoid densely populated and sensitive areas and high traffic times.			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		– 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 project site: high noise construction activities will be positioned as far away from sensitive sites as possible. – Drilling site will be enclosed by fence to reduce noise, if necessary – To minimize 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.			
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	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	
		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 work 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. – There should be no final waste disposal on site. Waste incineration at or near the site is strictly prohibited. – Contractors will be held responsible for proper removal and disposal of any significant residual materials, wastes, and contaminated soils that remain on the site after construction. – Cuttings will be reused if they are non-toxic (e.g. as construction fill) or disposed of in a certified and engineered landfill facility.			
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	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	
		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 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 including drilling sites for geothermal deep-well will be made secure, discouraging access by members of the public through appropriate fencing whenever appropriate.	DI (plan design), Contractors (plan implementation)	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	
		– Emergency response system and health and safety protocols will be developed by the IA before construction of geothermal wells. If the concentration of H2S is high, the geothermal well will be shut down.			
	Worker Occupational Health and Safety	Contractors will implement adequate precautions to protect the health and safety of their workers: – 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, EHS General Guidelines and Occupational H&S guidelines.	EHS Plan Developed by LIEC	IA supported by LIEC	LIEC Budget
		– Identify and minimize the causes of potential hazards to workers. Implement appropriate safety measures. – 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 heat working environments in compliance with PRC occupational exposure limits for hazardous agents in work place Part 2: physical agents (GBZ 2.2-2007).	EHS Plan implemented by 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	
		– Ensure regular safety meetings with staff. – H_2S monitoring and warning systems will be installed. If the H_2S level is over 5 ppm, the well will be sealed and shut down. – Electrical safety risks especially related to existing power transmission line and drilling activities will be assessed and safety protocols will be developed following EHS Guidelines for Geothermal Power Generation and EHS Guidelines for Thermal Power Plants.			
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.

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
C. Operation Phase					
Air Pollution	Combustion Emissions	– Bag filters will be installed at the top of ash and slag warehouse for dust removal. – Low NOx burner, desulfurization system, denitration system and dust removal system will be installed to treat the exhaust gas before final emission. – CEMS system will be installed at the stack to monitor the exhaust gas – If emissions monitoring indicates exceedances of relevant standards, additional denitrification and/or particulate control emissions devices will be added in consultation with the Jinan EPB and the ADB. – Ambient monitoring will be undertaken at nearby receptors. – Use of 0.5% or less sulfur fuel	DI (plan design) Contractors (construction) IA (operation)	IA IA EA and EPB	Design and construction budget IA operation budget
Biomass Briquettes		– Keep records of biomass sources to confirm that they are made from wheat straw, corn straw, cotton straw and waste barks and branches from bushes and trees for city greening and orchard gardens. The supplies shall provide certificate that no biomass is sourced from forest.	IA	EA	IA operation budget
Offsets		– LIEC will support the IA in monitoring the number of coal boilers and household stoves that have been replaced and include the information in the environmental	IA with the support of LIEC	EA	IA operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		monitoring reports			
Wastewater	Discharge of Production and Domestic Wastewater	– Wastewater from pre-treatment process and concentrated water from chemical water treatment workshop and boiler blow down will be discharged to the municipal sewerage system. – No metal (chromium or zinc) permitted to use as scaling and corrosion additive. – Because drainage from circulation system is clean, part of the drainage will be recycled for dust control in workshops and the rest will be discharged to the municipal sewerage system. – Because wastewater generated by equipment and pump contains oil, wastewater will be treated in oil separator and will be discharged to the municipal sewerage system. – Wastewater from desulfurization system will be pre-treated by aerated oxidation, then alkali will be used to adjust pH of wastewater to make the metal precipitate. After the pH adjustment, organic sulfur and flocculant agent will be added to make magnesium sulfite precipitate. Treated wastewater will be discharged to the municipal sewerage system. – Because of the high operation temperature of denitration system, no wastewater but steam will be discharged by denitration system. – Domestic wastewater will be produced from worker	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	
		sanitation facilities. Domestic wastewater will be treated in digestion tank and will be discharged to the municipal sewerage system. – For deep well geothermal wells, extracted water and recharged water are in a closed system which mean no wastewater water will be generated during operation. Because there is a filter process installed in the closed system for groundwater filter, wastewater will be generated during operation will be from filter back wash and will be discharged to the municipal sewerage system. – An emergency water tank will be prepared for temporary storage of geothermal groundwater in case the injection well is blocked or leak happens due to flocculation or corrosion.			
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, which will meet national and IFC/EBRD workers accommodation requirements. – 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 for utilization and recycling. – Oily waste will be collected, transported and treated by a	IA, District Sanitation Departments	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	
		certificated 3rd hazardous waste treatment company.			
Chemical and Hazardous Materials	Inappropriate Management	- A register 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. - 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. Some chemicals will be stored off-site, such as water quality analysis chemicals which will be stored at an independent laboratory. - 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.	IA, Licensed Contactors	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	
		- Workers will be properly trained before handling hazardous wastes and have the 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 communication should be in an easily understood language and be readily available to exposed workers and first-aid personnel.			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		- 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. – Noise level at night at Domitory should be met to allow rest and all workers accommodation provided by the component should meet IFC/EBRD guidance on worker accommodation.	IA	EA supported by LIEC, EPB	IA operation budget
Community and Occupational Health and Safety	Risks to Workers and Community	– Operation phase EHS plans and traffic management plan will be developed and implemented and workers will be trained regularly on their implementation. – The nearby communities will be informed of the potential risks of well blowout, H2S exposure, seismic risk, fire	Plans developed by LIEC Plans	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	
		and explosion of biomass CHP and potential generation of ammonia from urea and the emergency response plan. – PPE including goggles, gloves, safety shoes, will be provided to workers. Correct standard dust masks will be provided to workers working with biomass. Noise protection equipment will be provided to workers in high-noise area. Noise areas with more than 85 dBA shall be marked and hearing protections shall be provided to workers. Appropriate masks will be provided to workers near urea area following the PRC standards. – Noise level inside control room should be no more than 60 dB. Control room and electric rooms will be mechanically ventilated by fans. – Storage of urea will follow the PRC General storage guideline for common chemicals (GB 15603-1995). – Daily average numbers for vehicles transporting biomass fuels are 23.5 times (load of one vehicle is 20 tons and working days are 300 days). Transportation route of the vehicles will use the existing expressway and urban roads except for exit and entrance. Vehicles transporting materials or wastes will slow down to 30 km/h and not use their horn when passing through or nearby sensitive locations, such as residential communities, schools and hospitals. – Provide training to workers on occupational health and safety, and emergency response. – Cable and pipelines will be grounded and equipped with anti-lightning devices where applicable. – Component site will be fence with restricted public	implemented by IA		

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		access. – 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. – Potential occupational electric and magnetic fields (EMF) exposure should be prevented/minimized through identifying potential exposure levels in the workplace, training of workers in the dentification of occupational EMF levels and hazards, implementing action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations. Personal exposure monitoring equipment should be set to warn of exposure levels that are below occupational exposure reference levels (e.g., 50 percent). – 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. – For fire and explosion hazard: use of automated combustion and safety controls; proper maintenance of boiler safety controls; use of automated systems such as temperature gauges or carbon monoxide sensors to survey biomass storage areas to detect fires caused by self-ignition and to identify risk points; storing flammables away from ignition sources and oxidizing			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		materials; defining and labeling fire hazard areas. – Managing closure of well heads including sealing well with cement, removing the well head, and backfilling depression around the well head, as necessary.			
	Emergency Response	A draft emergency risk and response has been established in accordance with 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 plant 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.	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	

		Annual Emergency Simulation
		– Simulated emergency exercises will be conducted 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 dispatcher of the			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		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, police, the city medical emergency center and other relevant public			

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Source of Funds
			Implemented by	Supervised by	
		officials should be notified. An emergency call list will be prepared and make it available at the plant control room.			

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.
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 and Zhouyan Village	Weekly during construction season	EMS	EA, EPB
	H_2S monitoring	Geothermal well drilling site		Contractor and IA	EA, EPB
	Compliance inspection of implementation of air pollution control measures	Construction site	Daily during construction season	IA	EA, EPB
Wastewater	Water sampling - COD, TSS, pH etc. following PRC requirements	- After drilling, both Shallow-groundwater and deep-well groundwater will be sampled and analyzed - 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 Zhouyan Village	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
	Ash and slag testing for compliance with PRC Organic Fertilizer Standards before selling	Ash and slag storage sites	Semi-annually	IA	EA, EPB
Hazardous and	Compliance inspections of	Storage facilities for fuels,	Monthly during	IA	EA, EPB

Subject	Parameter/Methodology	Monitoring Location	Frequency	Implemented by	Supervised by
Polluting Materials	implementation of hazardous materials management measures	oil, chemicals and other hazardous materials. Vehicle and equipment maintenance areas.	construction		
Shallow groundwater	pH, temperature, Hg and other metals, hardness, etc. following the PRC groundwater quality standards	Well sites	Once before 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
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					
Air pollutants generated from operation	Emission monitoring (PM, SO_2, NOx)	Exhaust stack	Quarterly	EMS	EA, EPB
	Continuous emission monitoring ($PM_{2.5}$, PM_{10}, SO_2, NOx)	Exhaust stack	Continuous	IA	EA, EPB

Subject	Parameter/Methodology	Monitoring Location	Frequency	Implemented by	Supervised by
	Ambient air quality at the receptors and at the area maximum predicted deposition ($PM_{2.5}$, PM_{10}, SO_2, NOx)	Nearby receptors	Quarterly	EMS	EA, EPB
Wastewater	Wastewater sampling - COD, TSS, pH etc. following PRC requirements	Discharge outlet to municipal sewer of the CHP Site	Quarterly during none heating season and once during heating season for two weeks per year	IA	EA, EPB
Solid Waste	Compliance inspection to of operation phase solid waste management measures implementation, contaminants in fly ash following the PRC standards	CHP Site	Semi-annually	IA	EA, EPB
Noise	Noise monitoring (1-h average level per World Bank EHS Guidelines requirement, day and night Leq dB(A))	Boundaries of the site and Zhouyan Village	Quarterly	EMS	EA, EPB
Hazardous and Polluting Materials	Compliance inspection of operation phase Hazardous Materials Management Plans (HMMPs) implementation	CHP Site	Semi-annually	IA	EA, EPB

Subject	Parameter/Methodology	Monitoring Location	Frequency	Implemented by	Supervised by
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	CHP Site	Semi-annually	IA	EA, EPB
Earthquake	Seismic monitoring	Geothermal injection well area	Semi-annually	IA	EA, EPB
Environmental acceptance	Compliance testing for environment acceptance	CHP 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 – Types of grievances and eligibility assessment **Implementation of Construction Phase EMP** – Impacts and mitigation measures – Monitoring and reporting requirements – Non-compliance and corrective actions	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
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 semi-annual environmental reports including EMP implementation and monitoring results for submission to the IA and EA. The PMO ESO with the support from the LIEC will prepare semi-annual 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 semiannual 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.

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			
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 EIA.

No.	Description	Indicators	
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							
1. Ambient Monitoring	**Unit**		**Unit Cost**	**# Times**	**Cost USD**	**Cost RMB**	**Source of Funds**
Air - TSP	Quarterly	$	300	36	$ 10,800	¥68,620	Counterpart Financing
Noise	Quarterly	$	200	36	$ 7,200	¥45,747	
Subtotal					***$ 18,000***	***¥114,367***	
2. Capacity Building	**Unit**		**Course Cost**	**# Times**	**Cost USD**	**Cost RMB**	
Construction Phase HSE Plan Development and Training	EHS Plan Development	$	2,000	4	$ 8,000	¥50,830	Counterpart Financing
	EHS Course Development	$	2,000	1	$ 2,000	¥12,707	
	EHS Course Delivery	$	4,000	1	$ 4,000	¥25,415	
Subtotal					***$ 14,000***	***¥88,952***	
TOTAL Construction Phase					***Cost USD***	***Cost RMB***	
					$ 32,000	***¥203,318***	

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	$	400	36	$ 14,400	¥91,493	
Continuous emission monitoring of exhaust gas	Continuous	$	10,000	1	$ 10,000	¥63,537	
Noise	Seasonal Sampling	$	200	36	$ 7,200	¥45,747	Counterpart Financing
Groundwater	Seasonal Sampling	$	200	36	$ 7,200	¥45,747	
Wastewater	Seasonal Sampling	$	150	18	$ 2,700	¥17,155	
Subtotal					***$ 41,500***	***¥108,648***	
2. Capacity Building	**Unit**		**Course Cost**	**# Times**	**Cost USD**	**Cost RMB**	
Operation Phase HSE Plan Development and Training	EHS Plan Development	$	2,000	4	$ 8,000	¥50,830	Counterpart Financing
	EHS Course Development	$	2,000	1	$ 2,000	¥12,707	
	EHS Course Delivery	$	4,000	1	$ 4,000	¥25,415	
Subtotal					***$ 14,000***	***¥88,952***	
TOTAL Operation Phase					***Cost USD***	***Cost RMB***	
					$ 55,500	***¥352,630***	
GRAND TOTAL Construction + Operation					***Cost USD***	***Cost RMB***	
					$ 87,500	***¥555,949***	

LIEC	**Unit**	**Monthly Cost**	**# Months**	**Cost USD**	**Cost RMB**	ADB Loan

APPENDIX II: EXISTING FACILITY DUE DILIGENCE ENVIRONMENTAL REVIEW – WASTEWATER TREATMENT PLANT OF JINAN NEW MATERIAL INDUSTRIAL PARK

A. Introduction

1. This is a due diligence rapid environmental review of the Wastewater Treatment Plant of Jinan New Material Industrial Park (JNMIP) (hereafter referred to as the JNMIP WWTP), being conducted as part of the preparatory assistance for the development of the proposed biomass Combined Heat and Power (CHP) component of the proposed Shandong Clean Heating and Cooling Project in Shandong Province of the People's Republic of China (hereafter referred to as the Project).

2. This component will provide district heating services to JNMIP by multiple heating sources to ensure secure and efficient heat supply, including biomass CHP plant and geothermal energy. The component will provide district heating to 1.536 million m^2 of which, 614,400 m^2 are residential area and 921,600 m^2 are industrial park and produce power which is sold to the electric power grid. Through energy saving and integration of clean and renewable energy sources, the component will replace inefficient coal fired heat only boilers thereby reducing ambient air pollution in Jinan City.

3. This component will utilize reclaimed water from JNMIP WWTP. The JNMIP WWTP is therefore an associated facility of the component, and as per the ADB Safeguard Policy Statement (SPS), an environmental review of the associated facility is required.

B. Environmental Review Approach

4. This report is based on a site visit, consultations with JNMIP WWTP managers and technical staff, and a review of plant environmental and technical documentation. The site visit was undertaken May 29th 2018, and included the following participants:

Environmental Reviewers:
Dai Lei, National Environmental Safeguards Specialist

Jinan Thermal Power Co,. Ltd
Mr. You Cheng, Manager
Mr. Bai Xiao, Environmental staff.

JNMIP WWTP:
Mr. Wu Gang, Deputy Manager.
Ms. Zhang Xiaoqing, Operation Staff.

5. Documentation reviewed during the site visit included:
- EIA Approvals;
- Environmental monitoring reports.

C. Project Description

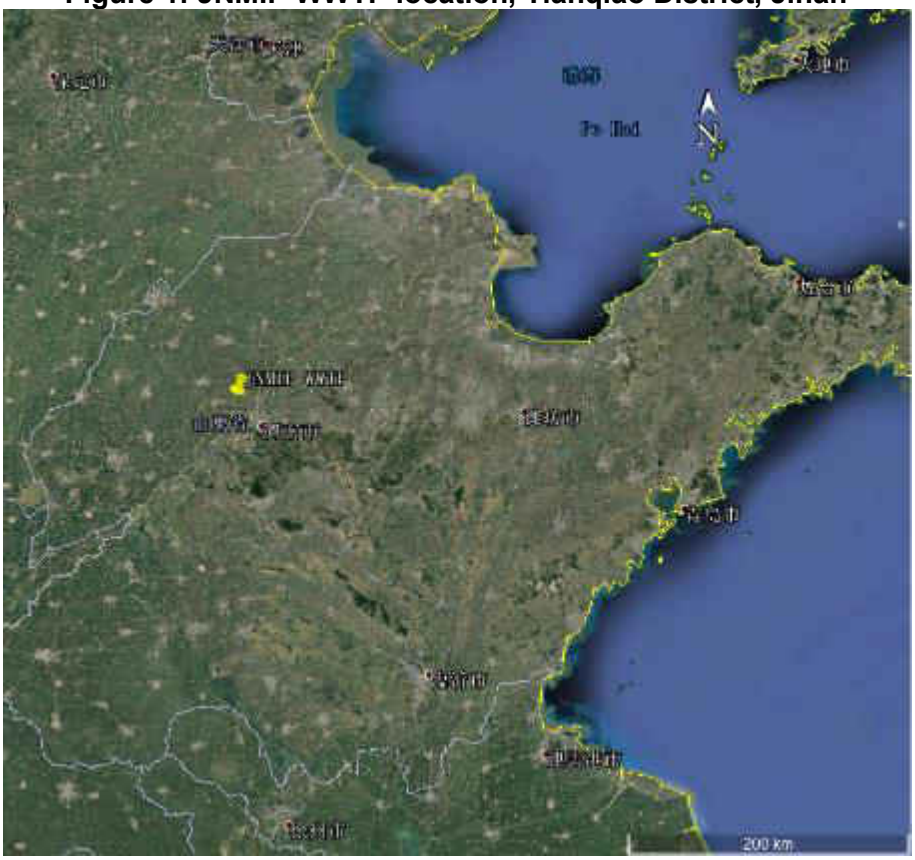
1. Type

6. The facility is a municipal WWTP in JNMIP, Tianqiao District of Shandong City, Shandong Province, in the People's Republic of China (PRC). It is responsible for treatment of domestic wastewater and production wastewater in JNMIP. It is owned by management committee of JNMIP, which is responsible for the management of JNMIP.

2. Location

7. The JNMIP WWTP is located on a 350 m^2 site at Xinyuan Road, Tianqiao District, Jinan City (**Figure 1**). The area is industrial, though Zhouyan village is at the north. The WWTP is bordered to the north by Xinyuan Road and Zhouyan Village; to the east by Hongxin Road; to the west by Huanwan Road; to the west by Jinan Huarun Company and to the south by Xingge Road (**Figure 2**).

Figure 1: JNMIP WWTP location, Tianqiao District, Jinan



Source: Google Earth.

Figure 2: JNMIP WWTP and surrounding area

Source: Google Earth.

3. Purpose and Capacity

8. The JNMIP WWTP currently provides treatment of industrial and domestic wastewater to JNMIP. Its current treatment capacity is 15,000 m^3 per day. The JNMIP WWTP became operational in 2008 when JNMIP started operation and had a capacity of 15,000 m^3/day.

9. The JNMIP WWTP provides primary sedimentation treatment, secondary anaerobic/anoxic/oxic (A/A/O) treatment, and tertiary treatment with mechanical flocculation, sedimentation and sand filters. Final disinfection is provided through ultraviolet. Treated effluent is discharged to Tuhai River.

10. **Figure 3** shows an aerial view of the WWTP.

Figure 3: JNMIP WWTP layout

Source: Google Earth.

Figure 4: JNMIP WWTP

(i) Screen room and aerated grit chamber

(ii) A/A/O treatment tank

(iii) Sludge concentration tank

(iv) Flocculation precipitation and sand filter tanks

4. Sludge

11. Sludge generated in wastewater treatment will be dewatered by filter press and drying tank. Dewatered sludge generation ranges from 25 to 30 m^3/d. All dewatered sludge is collected and trucked by Jinan EPB certificated companies for treatment at certified landfills.

D. Environmental Management

1. Environmental Impact Assessment

12. The JNMIP WWTP is reported to be in compliance with all relevant PRC EIA requirements. An EIA was approved in 2006, and another was approved in 2013 for upgrading of treatment to meet more stringent standards.

13. During site visit, the EIA approvals were provided to the consultant for review.

2. Relevant Environmental Standards

14. The JNMIP WWTP is required to meet the Class 1A standard from *Discharge Standard of Pollutants for Municipal Wastewater Treatment Plants* (GB 18918-2002) (**Table 1**).

Table 1: Class 1A, Discharge Standard of Pollutants for Municipal Wastewater Treatment Plants (GB 18918-2002)

No	Item	Unit	Limit
1	COD	mg/l	50
2	BOD	mg/l	10
3	SS	mg/l	10
4	animal and vegetable oil	mg/l	1
5	Petroleum	mg/l	1
6	Anionic surfactant	mg/l	0.5
7	Total nitrogen	mg/l	15
8	Ammonia nitrogen	mg/l	5
9	Total phosphorus	mg/l	0.5
10	Chromaticity		30
11	pH		6-9
12	Fecal coliforms	no./l	1000

3. Environmental Monitoring and Compliance

15. The WWTP is equipped with a Jinan EPB managed continuous emissions monitoring systems (CEMS) that monitors discharged wastewater in real time for chemical oxygen demand (COD) and ammonia nitrogen (NH_3-N). Data is sent electronically to the Jinan EPB Data Center (**Figure 5**). If non-compliance is found by CEMS system, staff from Jinan EPB will go to the WWTP to check in one hour.

16. Manual emission monitoring is also undertaken on a quarterly basis by the Jinan EPB for calibration. The company also does internal monitoring of emission operational parameters which are used to manage operation of the WWTP.

17. Noise monitoring is undertaken at the site boundary on a quarterly basis.

Figure 5: Jinan EPB wastewater CEMS building, JNMIP WWTP

Source: Consultant.

18. Staff reported that according to the EPB CEMS, the WWTP was 100% in compliance in 2017. Staff also provided environmental monitoring reports from January 2017 to April 2018. The monitoring reports demonstrated that the JNMIP WWTP was compliance with standards for the periods from January 2017 to April 2018. Environmental monitoring reports also confirms the compliance from January 2017 to April 2018.

E. Conclusion

19. Based on this rapid environmental review, the JNMIP WWTP has undergone an appropriate EIA process and has received the necessary Environmental Acceptance by the Jinan EPB. Staff reports that the WWTP is in full compliance with relevant wastewater emission standards, and this has been confirmed by environmental monitoring reports.